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PAPERS IN AGRICULTURE

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

The program of the Agriculture Section was devoted to a symposium of six papers on the general subject, "Problems of the Soybean Industry."

The paper by Otto Eisenschiml, Scientific Oil Compounding Company, Chicago, entitled "The Use of Soybeans in Industry," was not presented for publication.

Average attendance at the meeting was seventeen, maximum was twenty-five.

The acting chairman was reelected for 1933-34.

(Signed) H. W. MUMFORD, *Chairman*

HISTORY OF SOYBEAN DEVELOPMENT IN THE UNITED STATES

BY

C. H. OATHOUT

Western Illinois State Teachers College, Macomb, Illinois

ABSTRACT

The soybean has been known in most of the countries of the Orient since prehistoric times. Over fifty different names have been listed by Piper and Morse, United States Department of Agriculture, thus showing its great antiquity. It is said to have been mentioned by the Chinese Emperor Chen Nung in the ancient Materia Medica in the year 2838 B. C. It is also described in several ancient Chinese dictionaries under different names, one of which was *sou* from which, these authors suggest, our recent names *soi*, *soy*, *soja* and *soya* are probably derived. DeCandolle says it is doubtless the plant called *shu* in the Chinese writings of the time of Confucious; that the species was wild in Cochin-China to the south of Java when the ancient people of this region began to cultivate it at a very early period.

A good deal of confusion seems to have prevailed for many years concerning the correct botanical name. However, after much study of the subject Piper and Morse concluded that the correct name must be *Soja max*.

The soybean found its way into Europe near the close of the eighteenth century, its culture having been recorded in England in 1790. It was introduced into the state of Pennsylvania in the United States in 1804, but for many years received only occasional notice. Morse, in Farmers' Bulletin 1520, states that since 1890 nearly all of the state experiment stations in the United States have conducted experiments with it.

It has been only during the last twenty to twenty-five years that the farmers of the United States have given attention to the crop, though a report read by W. H. Stoddard of Macoupin County, Illinois, at a farmers' institute in 1898 shows that the farmers of that community had a good deal of practical knowledge concerning it. No figures showing the acreage produced in the United States are given until the year 1917 when 460,000 acres were reported from seventeen states. In 1924 there were 2,500,000 acres grown of which 613,000 acres were harvested for seed. In 1930 the acreage grown for seed was 1,105,000 of which 843,000 acres were grown in seven states. Illinois led with 321,000 acres, followed in order by North Carolina, Missouri, Iowa, Ohio, Tennessee, and Oklahoma.

Probably the most important by-product of the soybean is oil which is used in the manufacture of paint, varnish, linoleum, oilcloth, artificial leather, etc. In the year 1922-23 9,528,000 pounds of soybeans were used in producing 1,482,000 pounds of oil. By 1929-30 this had increased to 95,676,000 pounds of beans producing 12,482,000 pounds of oil.

Experiment stations in the United States have done much in improving varieties. This is notably true in Illinois, where, under the direction of Dr. C. M. Woodworth, the Illini, an early variety of great merit has been developed.

SOYBEAN PRODUCTION IN ILLINOIS

BY

W. L. BURLISON

University of Illinois, Urbana, Illinois

ABSTRACT

Six hundred and seventeen thousand acres of soybeans were produced in Illinois in 1932 with a crop that amounted to over 6 million bushels. Because of the potential importance of the soybean in Illinois, the Illinois Agricultural Experiment Station has conducted through more than a quarter of a century investigations on the production and utilization of this crop. The present paper is intended as only a very brief resumé of certain phases of our studies.

Varieties.—Definite studies on soybeans in Illinois were first made by the Illinois Agricultural Experiment Station in 1897. From that day to this, literally scores of varieties and types have been under observation and trial. Superior varieties have been discovered from time to time which, naturally, have largely supplanted those of earlier domination. For example, varieties of outstanding promise recommended in 1923 were Manchu and Virginia, and in 1932 were Illini, Dunfield, and Mansoy.

It is interesting to note the range in yield of the varieties. They vary upward from 16 bushels per acre to approximately 35 bushels. Yield has always been considered an important factor in choice of variety, but present-day industrial requirements have shifted emphasis to quality as well as yield.

A selection by the method of plant breeding made by Doctor C. M. Woodworth of the Department of Agronomy here at this Station, called the Illini, was distributed in 1928 and has averaged 40 bushels per acre for a period of ten years. About half of the beans now grown in Illinois for commercial purposes are of this new variety.

Date of Seeding.—Experiments carried on for the past six years have brought out the fact that date of seeding soybeans is an important matter in production, especially when quality is considered. Varieties have been seeded at ten-day intervals from May 1 through and including June 20, and the results show that there is practically no difference in the yield of the first three seedings; namely, May 1, May 10 and May 20, but from the June 1 planting yields declined until the last seeding June 20.

Rate of Seeding.—Five years' results on the effect of rate of seeding on yield have changed opinion in regard to this matter. Years ago, when seeded in rows, it was thought that 30 pounds an acre were quite sufficient. Now a larger amount (50 to 70 pounds) is commonly used. In seeding beans "solid," as in the case of planting with the 8-inch grain drill, a higher rate of seeding is required than where the beans are seeded in 24-inch rows. The yields, however, from the solid seedings were distinctly lower than the yields for the 24-inch rows. The labor item and available equipment are of considerable importance in determining this practice.

Longevity and Storage.—The matter of storage and longevity, as it affects yields are, of course, closely related. Studies on longevity of seed of five varieties stored under favorable conditions show that there is a steady loss in the yield of beans when stored for a period of from one to five years. Rapid deterioration in the germination for the first year is not necessarily true. After a two-year period, however, there was a distinct loss in germination and yield although varieties differ materially in the length of time they remain viable and in the ability to produce vigorous plants when seeded.

THE USE OF SOYBEANS AS HUMAN FOOD

BY

EVERETT E. ROQUEMORE

Allied Mills, Inc., Chicago, Illinois

ABSTRACT

Although the soybean has been referred to as the meat and milk of the Orient, the average American knows little if anything regarding the value of products of this plant in the human diet. The possibilities in the use of the soybean as a food for humans as well as for livestock should be of great interest to the thousands of farmers who have become interested in producing this crop, but who now are directly confronted with the problem of widening the market outlet for the soybean.

History tells us that soybeans have constituted the principal source of protein in the Chinese diet for more than 100 generations. Scientists in different countries, particularly Italy, Germany, England, and France as well as our own country, have been interested in investigating the soybean for human nutrition and the facts regarding the value of the soybean as a source of food supply are gradually gaining recognition.

The medical profession has recognized the soybean as a valuable food for diabetics on account of its freedom from starch. It also carries an unusual amount of those peculiar nitrogenous compounds, designated collectively as "protein", which play such an essential role in the nutritive processes.

In the Orient where the soybean to a large degree takes the place of milk in the diet, a cheese-like material is prepared by a well known process and extensively used.

The chemical composition of the soybean as compared with that of our ordinary grain products is extremely peculiar. Not only does it analyze as high as 35 to 40 per cent of protein but it also carries 17 or more per cent of oil, besides 5 or 6 per cent of minerals. Moreover, it is found to be very rich in vitamins, so that altogether the soybean represents the most concentrated, natural, common foodstuff available.

A soybean flour is now coming into use. It is prepared by dehulling the beans, extracting the surplus oil, and bolting the pressed cake into a fine flour. This product has a pleasing nut-like flavor. The flour is used in making breads, cakes, pastries, ice cream and other food materials.

A substance of special value extracted from soybeans is lecithin, formerly prepared largely from yolks of eggs. Lecithin is a phosphorus compound useful in building up nerve tissues.

Soy sauce is another oriental preparation that is now being made in this country under sanitary regulations.

Soybean sprouts are prepared by soaking the beans for a period in water in a warm place and permitting them to sprout through a period of four to six days. The sprouts are then kept in a cool place until served as salad, in stews, and in other ways.

The Chinese prepare soybean milk by grinding with water between millstones, filtering through cheesecloth, and boiling. This material will coagulate, forming a curd which resembles cheese.

When used as a binder for meats in the making of sausages and meat loaves, Soya Flour improves the flavor and appearance of products in which it is blended without increasing cost.

Soybean oil, properly refined, makes an excellent table oil.

Thus with all these various products for human consumption it would seem that the extension of the utilization of the soybean can well be encouraged, thus creating a wider market outlet for this valuable farm crop.

THE FEEDING OF SOYBEANS TO LIVESTOCK

BY

C. W. HUDELSON

Illinois State Normal University, Normal, Illinois

ABSTRACT

The soybean is a native of southeastern Asia and has been grown in China, India, and Japan for more than 5000 years. It is the most important legume of those countries. Although the soybean was first introduced in this country in 1804 it is only within the last three decades that it has found an important place in American agriculture.

Summarizing, types of soybean feeds are as follows:

Soybean Pasture.—Soybeans as a pasture crop are not comparable to other legumes, rape, peas and oats or the grasses. The most satisfactory use as a pasture crop is for utilization when the crop is nearly mature and the beans are starting to harden.

Soybean Silage.—Soybeans can be made into silage successfully if allowed to dry in the field until the moisture content is reduced to 60 per cent. A more successful method is to mix alternate loads of soybeans and corn. Legumes, at best, however, do not make as satisfactory silage as corn.

Soybean Hay.—Soybean hay is about equal to alfalfa in feeding value and is ready to harvest the same season it is planted. A good grade of hay can be made from it at almost any time in its growth, but as the best hay comes from a small stemmed leafy plant, soybeans can best be cut not later than when the pods are small.

Soybean Straw.—Soybean straw in analysis seems to be only slightly lower in feeding value than timothy hay, containing five pounds less digestible nutrients per hundred pounds of feed. The nutritive ratio of the two feeds is about the same. Timothy hay is finer, of course, and usually will be eaten up cleaner.

Whole Soybeans.—Soybean grain contains about 36 per cent protein, 5 per cent ash and 17 per cent oil. The beans are not palatable to pigs and their protein and ash do not supplement the common farm grains well. If the beans are fed in sufficient amounts to balance a ration of corn for fattening hogs (about 20 per cent), the oil of the beans causes a soft pork.

Ground Soybeans.—Ground soybeans have been found slightly superior to cottonseed meal for milk production. In one instance where soybeans formed one-half the concentrate mixture for dairy cows, a soft unsatisfactory butter was produced. A smaller proportion should produce satisfactory results.

Soybean Oil Meal and Soybean Oil Cake.—Soybean meal is greatly esteemed by western dairymen and is an excellent protein-rich feed for swine. Soybean oil meal cake is fully equal to high grade linseed meal as a protein-rich concentrate.

Conclusions.—Soybeans furnish home grown protein feed which is an urgent need on every livestock farm. They yield well, therefore they are an economical feed.

Of the several forms in which a part or the whole plant may be offered the most popular and generally used are the hay and the oil meal. The classes of livestock that make the best returns on certain types of soybean feeds are: Dairy cattle, beef cattle, and fattening hogs on oil meal and cattle and horses on hay. The one main caution to observe is to take proper steps to avoid production of soft pork.

ECONOMIC BASES FOR PRESENT AND FUTURE PRODUCTION OF SOYBEANS IN ILLINOIS

BY

R. C. Ross

University of Illinois, Urbana, Illinois

ABSTRACT

The farmer's decision on soybean acreage focuses upon two economic considerations—relative profitableness, and the place of the crop in the farming system. During recent years improvement in varieties, cultural practices and harvesting methods have markedly increased yields, and the building up of a marketing organization has put the crop on a commercial basis.

The acreage of soybeans grown in Illinois has increased from 1,000 in 1914 to a peak of 771,000 in 1931. While some soybeans are now grown in all parts of the State, approximately 85 per cent of the acreage is located in a belt running east and west across the State, 175 miles in width from north to south. In the northern three-fifths of this belt, the part lying north of the Shelbyville Moraine, the acreage devoted to seed or grain production exceeds that used for hay, while the reverse situation is true in that part of the belt lying south of this line. Economically, the method of utilization is significant, since it marks the difference between use on the farm where grown and disposal through commercial outlets. As a grain crop, soybeans compete with other grain crops; as hay, with other hay crops. Relative profitableness of soybeans with other grain crops is shown by comparing the amounts of income above operating costs and taxes for various periods (Table 1).

TABLE I

Average Incomes per Acre Above Operating Costs and Taxes for Various Crops and Designated Periods Champaign and Piatt Counties[1] [3]

	10-year average 1923-1932	5-year average 1928-1932	3-year average 1930-1932	1-year 1932
Corn	$11.27	$7.95	$2.16	$—3.00
Winter wheat	9.52	6.75[2]	2.25	3.45
Soybeans (threshed)	6.83	5.49	— .18	.71
Soybeans (combined)		9.03	2.70	4.86
Soybeans (hay)		5.70	2.97	—1.72
Oats	4.43	3.33	1.26	.15

[1] Unpublished data and annual mimeographed reports, Department of Agricultural Economics, University of Illinois.
[2] Four-year average, 1929-1932. No records for 1928 due to winter killing.
[3] Incomes based on average market values for month of harvest.

Under recent price relationships, soybeans have an evident advantage which, however, is less obvious in the longer periods during which more normal price relationships prevailed. These figures also show one reason for the shift from binder and thresher to the combine in harvesting soybeans.

During short periods when economic conditions force every possible economy it is likely that the difference between direct cash outlay and cash returns becomes the immediate criterion for crop adjustments. Cash outlays

in growing corn, wheat, oats, and soybeans differ but little, hence the tendency is to favor the crop with the largest cash income. For the three-year period 1930-1932, cash incomes in Champaign-Piatt counties were corn, $14.13; wheat, $12.72; soybeans—threshed, $12.58, combined $13.37; and oats, $7.93. From the standpoint of profitableness, soybeans are bidding strongly for second place among grain crops.

In the farm organization, soybeans are widely adaptable. Their place as a direct income-producing crop has been shown; as an emergency crop they may replace winter-killed wheat as grain, or clover failure as hay. As a hay crop the operating costs are relatively high, yet with good yields, ton costs are not excessive. The present tendency to use home grown feeds and to defer liming programs favors expansion of hay production to meet farm needs. Commercial outlets for soybean hay have been but little developed.

Even in the heaviest producing areas of Illinois the ratio of soybean acreage to other crops suggests the possibility of much further expansion through replacement of lower profit crops. The much wider extension of the present commercial areas not only in Illinois but in other important producing areas indicates the possibilities of increasing the supply if prices warrant.

As yet, the demand is predominantly on the farms where grown. For the entire country, of the 1929 and 1930 crops, 56 per cent was cut for hay, 15 per cent grazed, and 29 per cent harvested for beans. Development of feed uses depends largely upon numbers of animals and feeding methods. Harvested beans have several outlets—crushing, seed, feed, export, and human food. While all of these may be expected to provide for expansion, the greatest possibilities doubtless lie in the broad and varied field of industrial utilization. The economic problem of determining the extent to which the potential physical production will be carried is that of developing commercial uses in sufficient variety and volume and an adequate marketing mechanism in order to return to the grower remunerative prices for the beans produced for market.

PAPERS IN ANTHROPOLOGY

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

Six papers were presented before the meeting of the Anthropology Section. The following were not presented for publication:

"Pictorial Survey of Archeology in the Mound Area," by Thorn Deuel, University of Chicago, Chicago, Illinois.

"An Archeological Survey of Cahokia Creek East of Collinsville Bluffs," by W. H. Hunter, University of Illinois, Urbana, Illinois.

"Projected Research in the Archeology of the Ohio-Mississippi Confluence in Southern Illinois," by Bruce Merwin, Southern Illinois State Normal University, Carbondale, Illinois.

Attendance averaged twenty at the Friday afternoon meeting. Approximately seventy persons attended the field trip to Cahokia Saturday morning.

Mr. Thorn Deuel, University of Chicago, was elected chairman of the section for 1933-34.

(Signed) A. R. KELLY, *Chairman*

SUGGESTIONS FOR THE QUANTIFICATION OF POTTERY STUDIES IN THE LABORATORY

BY

FREDERICK R. MATSON, JR.

University of Illinois, Urbana, Illinois

As it is felt that objective descriptions would prove of value in describing the pottery of a district and would aid in the comparative study of pottery, the following suggestions are offered:

Body Composition.—The study of a thin section or a powder of a representative sherd with the aid of a petrographic microscope would not only indicate the physical composition of the body which, with most primitive pottery, approximates that of the unfired ware, but would also aid, together with the study of State Geological Survey bulletins, in the identification of the clay beds used. With this information it could be determined whether or not the non-plastic tempering material occurred naturally in the clay. The nature of the non-plastic material, the percentage present in the body, and the range of grain size might be determined either by means of the thin section or by an X-ray photograph of the sherd.

Texture.—The determination of the porosity of a ware would furnish a means of describing its texture, the coarser ware having the higher porosity. In reporting the surface texture of the sherds, a hard needle might be drawn over the surface under controlled conditions with its vertical motion amplified and recorded, the resulting curve then being mathematically analyzed.

Hardness.—Among the methods for determining hardness are scratching, grinding, boring, and pressure and impact tests. For pottery studies, Moh's scale of hardness which is used by mineralogists seems to be quite satisfactory. Where necessary, some intermediate minerals can be added to this scale to further limit it. As the "skin effect" of the surface of the pottery may greatly influence the hardness, the tests should be made on undamaged surfaces of sherds. The hardness of the sherd will give some indication as to the temperature to which the clay was fired.

Color.—There are many methods which might be used to define color or color variation in a sherd series, such as Munsell's color sphere with its three variables—hue, value, and chroma; a book of standard color shades; a color top; or a recording photo-electric analyzer which will automatically plot a color curve in less than a minute showing the amount of each wave length of light reflected from a surface when illuminated from a standard source. Although the analyzer would be the most accurate, the book of colors would probably be the most practical to use in studying sherds. A series of sherds selected from those found at a site might be used to illustrate the color variations in the pottery of that place, and to determine the percentages of the different colors found.

Density.—A statement as to the bulk density of the sherds would be a useful addition to a report.

If a series of objective standards were adopted by archaeological laboratories studying primitive pottery, the resulting uniformity of reports would greatly aid workers in this field.

A CLASSIFICATION OF CAHOKIA PROJECTILE POINTS

BY

P. F. TITTERINGTON

St. Louis, Missouri

ABSTRACT

The material here classified is from the surface of the camp sites which are located between the mounds. It represents the combined collections of three men over periods of twenty, fifteen, and twelve years respectively, and material secured from local farmers.

The 2523 arrowheads that can be classified range from ⅝ to 2⅜ inches in length; 1020 (40.4 per cent) are triangular and 1503 (59.6 per cent) are notched. Of the 1020 triangular points, 672 (65.8 per cent) have slightly convex sides, 252 (24.7 per cent) have straight sides, and 96 (9.5 per cent) have slightly concave sides; 958 (93.9 per cent) have straight and 62 (6 per cent) have concave bases.

Of the 1503 notched points, 1284 (85.4 per cent) are side notched and 219 (14.5 per cent) are corner notched; 1217 (94.7 per cent) have straight and 67 (5.2 per cent) have concave bases. In the side-notched points the head is rather wide. The group of corner-notched points includes all that do not have wide heads. Some of these should doubtless be classed as side-notched but since the heads are not rectangular, they are not included in the predominating group.

Of the total number of arrowheads, 211 (8.3 per cent) have a notch at the center of the base; 208 are side-notched. They are worthy of special note on account of the materials and workmanship. Fifty-one are translucent, a few being made of highly colored almost transparent agate, and the chipping is of the finest, the arrowheads being thin, well made and regular, most of them completely chipped on both sides. Only a few are made from flakes.

Most of the base-notched points (177) have one pair of side notches and are known locally as three-notched points. A few have more than one pair of notches. In the multiple-notched points the primary pair of notches is considerably deeper than the more shallow secondary pair or pairs. There are seventeen five-notched points with one pair of primary and one pair of secondary notches; five seven-notched points with one pair of primary and two pairs of secondary notches; two nine-notched points with one pair of primary and three pairs of secondary notches; and seven points so closely notched that they are classed are serrated.

Twenty-one points which have no base notch have one pair of primary and one pair of secondary notches (four-notched); four have one pair of primary and two pairs of secondary notches (six-notched). In all multiple-notched points, the secondary notches may be above, below, or above and below the primary notches.

Fifty-five of the triangular and twenty-five of the notched points (3.1 per cent of the total) are serrated. Ten points have a highly polished strip down the center of one side. This polish is the same as that seen on bits of agricultural implements and suggests that they might have been made from chips from these implements.

The number of arrowheads is being increased each year. The collection is open for study and it is hoped that some time an archeologist will make a more scientific classification.

ON THE INVESTIGATION OF THE SECOND POWELL MOUND

BY

R. H. BRAY

University of Illinois, Urbana, Illinois

ABSTRACT

This report discusses briefly an attempt to apply soil chemistry to the study of the mound structure of the second Powell Mound. The work was done in cooperation with Doctor Kelley of the University of Illinois.

The main feature of this mound was a dark-colored, fine silty clay soil material making up the bulk of the mound which rested on a natural sand base. This was covered by a shallow sandy material, not included in the investigation because of its disturbed condition. The soil material has been undisturbed since it was laid down, except in the dyke formations found cutting through the mound. Vertical samples from the top to the base of the undisturbed soil material were taken for study. A slight columnar structure had developed in the upper part of the soil material.

The replaceable base content of the whole profile varied from 20 milliequivalents per hundred grams of soil in the surface to 22 in the soil just above the sand floor. The pH for the whole profile was around 7.0. This shows no leaching profile but is evidence for the original uniformity of the whole soil material. This uniformity makes possible the interpretation of the organic-matter study.

The organic nitrogen content showed a variation with depth from 0.086 per cent nitrogen in the top of the soil material to 0.113 per cent in the bottom of the soil material. The organic carbon varied similarly.

This is the reverse of a regular soil profile and is chemical evidence that the mound was built up by man and has since weathered to form the organic-matter curve found. This organic-matter curve is a result of many factors, among which time is of greatest importance. Although no definite length of time can be associated with this one curve, there is a possibility that relative age can be established on mounds built of fairly uniform material by comparing the nature of the curves obtained. The careful vertical sampling of mound material as a regular part of mound study is recommended.

The question as to whether the dyke formations were recent or not has been raised. If recent, the organic matter curve for a vertical sampling of the dyke material would be erratic. If they were cut through the mound shortly after the mound was built this curve would follow the curve of the undisturbed portion of the mound. Unfortunately no dyke samples were taken.

This emphasizes the importance of taking vertical samples from all structural features within the mound.

PAPERS IN BOTANY

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

Twenty-two papers comprised the program of the Botany Section. A number were withdrawn from publication, some being of such a nature that they did not lend themselves readily to abstracting and others requiring illustrations. They are as follows:

"Additions to Flora Peoriana," by V. H. Chase, Peoria Heights, Illinois.

"Rust Observations in the Illinois Winter Wheat Areas in 1932," by Kenneth Wright, Bloomington, Illinois.

"A Comparison of the Size Range and External Characteristics of the Spores of Modern and Fossil Lycopods," by Orrin J. Henbest, University of Illinois, Urbana, Illinois.

"Pollen Analysis of Some Water-deposited Sediments," by P. K. Houdek, Robinson, Illinois.

"*Primula mistassinica* in Illinois and the United States," "Unique Plant Distribution," and "Apple River Canyons," by H. S. Pepoon, State Natural History Survey, Urbana, Illinois.

"The Skunk Cabbage in Winter," by Jesse L. Smith, Highland Park, Illinois.

"Forest Distribution in Crawford County," and "Tree List for Crawford County," by S. Ray Bradley, Robinson, Illinois.

"False Indigos of the Mississippi Valley," by J. M. Greenman, Missouri Botanical Garden, St. Louis, Missouri.

"Three Fungal Species Parasitic Upon Algae," by Myrtle M. Burk, University of Illinois, Urbana, Illinois.

"Development of Zinnia under Soil Moisture Control," by Charlotte L. Grant, University of Illinois, Urbana, Illinois.

Average attendance at the meeting was forty, maximum was sixty.

Mr. E. L. Stover was elected chairman for 1933-34.

(Signed) H. S. PEPOON, *Chairman*

RESISTANCE OF FUNGOUS SPORES TO LOW TEMPERATURES

BY

CONST. J. ALEXOPOULOS AND J. DRUMMOND

University of Illinois, Urbana, Illinois

The study of the effects of very low temperatures on lower plants has been mainly limited to bacteria and yeasts. In 1902, Macfayden and Rowland (*1*) exposed some yeast cells and several types of bacteria to liquid hydrogen temperatures (about -252° C.) for a period of six months. In no case was the vitality or the physiological properties of the micro-organisms impaired by such treatment. Tanner and Williamson (*3*) and Tanner and Wallace (*2*) cite other experiments in which the resistance of bacteria and yeasts to low temperatures was shown. Experiments by Tanner and Wallace (*2*) with *Clostridium botulinum* indicated that spores of this organism are able to withstand freezing at -16° C. for a period of fourteen months. On the other hand, Tanner and Williamson (*3*) have shown that prolonged action of freezing temperatures destroys certain yeasts and bacteria.

The writers undertook experiments to determine the resistance of fungous spores to liquid air temperatures (about -185° C.). The organisms used were: *Melanconium fuligineum* isolated from Grape, *Coniothyrium* sp. isolated from Elm,[1] *Eurotium herbariorum*, culture obtained from C. V. S., Baarn, Holland, and *Cytospora chrysosperma*, isolated from Willow.

Several methods of subjecting the spores to liquid air temperatures were employed: 1) A suspension of spores in sterile water was placed in a test tube and the latter immersed in liquid air; 2) spores were inoculated on a corn meal agar slant and the tube immersed in liquid air; 3) a sterile glass rod was dipped into a sterile water suspension of spores and after the water was allowed to evaporate the glass rod was immersed directly into the liquid air. All three methods were employed with each of the organisms used and controls were maintained in each case.

After an hour's exposure to -185° C. the spores were brought to the laboratory and inoculations were made on corn meal agar with spores taken from the water suspension and from the glass rod. In all cases, germination of the spores and normal growth took place, the colonies resulting from frozen spores being in all ways similar to those resulting from untreated spores.

There were some indications that the mycelium of certain fungi was fatally injured by exposure to liquid air temperatures, transfers made from treated mycelium failing to grow. Experiments will be continued with both spores and mycelium and the results will be reported later.

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(*1*) MACFAYDEN, A., and ROWLAND, S., On the suspension of life at low temperatures, Ann. Bot., 16:589-590, 1902.

(*2*) TANNER, F. W., and WALLACE, G. I., Effect of freezing on micro-organisms in various menstra. Proc. Soc. Exp. Biol. and Med., 29:32-33, 1931.

(*3*) TANNER, F. W., and WILLIAMSON, B. W., The effect of freezing on yeasts. Proc. Soc. Exp. Biol. and Med., 25:377-381, 1928.

[1] Isolated by Mr. H. Harris of the Illinois Natural History Survey, whom the writers wish to thank for supplying them with a culture of the organism.

SCIENTIFIC BOTANICAL DESIGN

BY

EMMA C. CRUMMER

Chicago, Illinois

Scientific Botanical Design is a three-fold subject: science is classified and established knowledge—comprehensive information; botanical pertains to plants and trees; design means to plan, to purpose. Then scientific botanical design must be something upon which we may depend as being true facts from the field of botanical research, and as designers we find our patterns for designing purposes.

It is one of the erroneous beliefs that there is always a conflict between science and art. One of our great masters in science has taught us that "Science leads—Art follows."

The designer's job is to create something beautiful. The field of scientific botanical research is wide open to the artist who is indeed welcome, because he has demonstrated that he has found what he was seeking in science, and is using it in art.

It has been said by some of our scholarly educators that "some day we shall be looking for God in our laboratories." That "some day" is here now. Out into the field we go, among the things which God has created—to find the Creator. There we shall learn that the Creator is greater than the thing created.

How may we use this new discovery? It is to be the foundation of a new school of scientific art and industry where students are free to experiment in science and art.

The old masters in art experimented in doing things in new ways, hence they became masters; and a master is one who has mastered something for human use and enjoyment. Moreover, he must be a pioneer, who can give convincing proof that he has worked out a method, a system, and a course of procedure, all in obedience to natural laws which he has learned from diligent study from the pages of "Nature's Book of Ornament" giving logical reasons for certain rules which are to be followed whereby the designer may create something original and scientifically beautiful.

It is very important where the patterns are obtained in nature as this, in a large degree, determines the quality and value of the design.

The author has learned by experimenting that fundamental laws will guide the designer in testing his work, which can only be gained by systematic training and a workable knowledge of his subject, namely, the internal plant morphology, from the viewpoint of the two-fold mastery, which must be both Botanist and Artist.

Here, too, is a wide field for the geologist and the chemist in experimental research to discover more truth in color harmony; seeking scientific ideas and how to use them.

FLOWER VARIATION IN ZINNIA

BY

CHARLOTTE L. GRANT

University of Illinois, Urbana

During an experimental investigation on the development of Zinnia under three soil moisture ranges—wet, moist and dry—certain flower variations were observed.

According to catalog description the Red Riding Hood variety of Zinnia possesses double flower heads with scarlet rays. This description should certainly apply to the terminal head of the main stem, and according to reported observations to branch flowers as well. In twenty-three greenhouse plants of this variety none showed scarlet rays in the axial head (at the top of main stem), and only two plants gave consistent orange color in all the flowers developed on one plant. In all other plants, different flower heads had different colors although never more than one color to a particular flower head. As many as four different colors have been found among the flowers of a single plant. Fourteen colors have thus far been found on the twenty-three plants.

Microscopic examination of freehand sections of the rays showed a distribution of color in the following manner: orange or yellow chromoplasts in the upper papillose epidermis, red pigment dissolved in cell sap, present in varying amounts or entirely lacking in the upper epidermal cells; chloroplasts abundant or few in the mesophyll. Thus, yellows with a greenish cast were due to an abundance of chloroplasts in the mesophyll. Scarlet ray color results from a combination of red sap (apparently dilute spectrum red) with orange chromoplasts. Apparently the influence of the chromoplasts is less than might be expected. The various shades of orange depend upon abundance of chromoplasts in the upper epidermis and chloroplasts in the mesophyll.

Some variation in doubling was apparent and in six heads disc flowers were wholly lacking. But excluding from consideration these variations one is puzzled to account for the presence of differently colored flowers on a single plant. Is this an inherent variation involving genetic differences originating in the buds which produce the several axillary branches with their terminal flower heads? Can it result from the rather peculiar environmental conditions? Can it be an expression of difference in carbohydrate nutrition for the several branches on a plant? Or can it be a combination of several of suggested influences?

The lack of uniformity in color of heads on the same plant, and among plants of the same environmental series together with absence of correlation between sequence of development of heads on one plant with change in color are indications of inherent variation within the individual plants. On the other hand the frequency of color variation is many times higher than is characteristic for somatic mutations.

The soil used, a sandy loam of pH 5.3 was found low in phosphates and nitrates. This might be considered a possible environmental influence on flower color. But if soil conditions are unfavorable to normal color development why should not all the flower heads of a plant develop alike?

CONSERVATION OF WILD FLOWERS AND SHRUBS A MUNICIPAL DUTY

BY

L. F. GUMBART

Macomb, Illinois

Our native wild flowers are fast becoming extinct because people who love them will not let them grow and mature seed. Native shrubbery is fast following the flowers, in spite of the fact that brush holds the hillsides and stops erosion. Encourage the hazel, the wild-crab, plum, the red and black haw, persimmon, sassafras, the prickly, aromatic, and paper ashes, the service bush and red-bud, the wahoo or spindle bush, the gooseberries and blackberries and the wild roses in the draws and washes and plant hickory, walnut, pecan, oak and the conifers on washed off knobs and give nature a chance to take care of some of her own flood control problems.

Just now when the early wild flowers are blooming we must not forget that many varieties are fast disappearing. As a general rule, of the early spring flowers only the violet and cranesbill should be plucked or transplanted in town. Most of the summer and fall flowers seed freely and so may be picked generously. Following is a list of some of the flowers which we should encourage in our wild parks by carefully planting such as are not already there: Hepatica, anemone, wind-flower, spring-beauty, buttercup, blood-root, yellow-puccoon, wake-robin, purple trillium, blue-bell, dutchman's breeches, may-apple, sweet-william, dogtooth violet, shooting star, jack-in-the-pulpit, pansy, hare-bell, solomon's seal, lady's slipper or moccasin flower—all spring flowers—and I must not forget the old prairie or Turk's cap lily, now seldom seen.

May we not all go back to our home town and if there is no wild park, check up on some available rough land, say twenty to a hundred acres, buy it as a community or induce someone to buy or donate it for the town! Clear a few level spaces for picnic, ball, and tennis grounds. Turn it over on honor to the boy and girl scouts or high school to rule and regulate. Give continued instruction and care toward developing a real nature's garden of ground flowers, tangled vines and shrubbery for the birds. When available, a good spring or brook is an added attraction, but good potable drinking water must be provided. A good substantial fence is the next consideration, then clean toilet arrangements and an open building of steel construction with sheet steel corrugated roof large enough to cover a good sized crowd should a storm arise. If the town has no large auditorium, consideration might be given the possibility of using this building for Chautauqua, politics, young folks conventions, 4-H work, etc. By all means, do not combine it with a tourist park.

Uncle Sam has national parks, Illinois has state parks, Cook County has forest preserves and beautiful parks and playgrounds. Why not a wild park and playground near every city and town in the State to help perpetuate the many beautiful native plants, shrubs, and trees and aid us all to know and appreciate the outdoors and what nature reveals to us of God and His wonderful works for the children of men.

LATE WINTER INJURY OF SOME COMMON TREES AND SHRUBS

BY

HUBERT A. HARRIS

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ABSTRACT

During the latter part of February, 1932, temperature conditions throughout Illinois were so mild that growth activities were initiated precociously in different kinds of trees and shrubs. Early in March, however, a sudden freeze occurred which seriously injured vegetative growth.

In the Champaign and Urbana vicinity the effects of winter injury ranged from slight to very severe. Among those woody perennials most seriously injured were elm, pussy willow, poplar, and privet.

The most conspicuous and common symptom associated with winter injury was the presence of numerous dead, bare twigs or small branches protruding either from the tops of injured trees and shrubs or occurring at the ends of lower lateral branches. Quite frequently portions of larger branches manifested the same dead and leafless appearance. The extent of dying back ranged from only a few inches to as much as several feet, in accordance with the particular species of plant.

Another common and striking characteristic of the winter-injured plants was the presence of much enlarged or partially opened buds killed by freezing. Buds of the most precocious trees and shrubs were fully opened when killed. Those woody perennials characterized by a more retarded growth showed only swollen or partially unfolded buds, while buds on other plants with a still more prolonged period of dormancy, were only slightly enlarged and had been killed, apparently, just as growth activities were being initiated.

The American elm (*Ulmus americana* L.) commonly suffered winter injury during the spring of 1932. The occurrence of an exceptionally dense or compact foliar growth immediately below the winter-killed twigs and branches was a conspicuous character manifested by severely injured elms. Such leafy growth originated from the premature development of buds normally developed at the bases of already expanded leaves. Ordinarily these buds would have remained dormant until the following spring.

The cultivated pussywillow (*Salix caprea* L.) was so commonly injured that very few instances were observed in which no serious effects of freezing were evident. Injury was most noticeable among the flower branches though some lower laterals were also injured.

Winter injury to poplar was also quite general and extensive. The Lombardy poplar (*Populus nigra* L. var. *italica* Du Roi) was more extensively injured than the White (*P. alba* L.), Carolina (*P. canadensis* Moench.), or Simon (*P. simonii* Carr.). Greater injury to the Lombardy poplar was due not only to its more general cultivation, but also to the fact that the tree is usually grown singly, or in rows, quite isolated from other trees, and left unsheltered.

The common privet (*Ligustrum vulgare* L.) suffered extensive, though only moderately severe, winter injury. In most instances no large portions of the plants were killed, but instead, it was of more common occurrence for numerous small twigs scattered throughout the bush to be killed.

Most noticeable among those trees and shrubs injured to a lesser extent was the hard maple (*Acer saccharum* Marsh.)

MATERIALS FOR DEVELOPING THE TECHNIQUE OF CONSUMPTION FOR FOODS

BY

M. FAITH MCAULEY

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The studies that have been made of our food crops have been concerned chiefly with problems of production and distribution. Techniques of production have been worked out for all of our leading crops and the technical information is available to anyone interested. In distribution, too, techniques have been developed.

The consumptive activity has received little attention to date. The consumer has only recently been recognized as an important factor in our economic scheme and production and distribution considered in terms of consumption. The education of the consumer is still left almost wholly to competitive commercial interests and is accomplished through the medium of modern advertising. This method is expensive, characterized by half truths and economic shortsightedness.

The intelligent buying of food is not only important, it is also difficult. Our food stuffs are many and varied and their purchase presents more difficulties than does the purchase of materials satisfying other human needs, such as clothing and shelter. Much technical knowledge covering a wide range of products is needed.

Many of our food products, even the most perishable, are raised in distant producing regions, brought to us by special transportation such as fast freight, express, and refrigerator car. They are held for delayed consumption in cold storage or are preserved for indefinite periods by drying, canning, freezing. Each new process leaves the consumer less well-informed concerning his food products and makes acquiring of new knowledge necessary.

Materials for developing the techniques in food consumption should furnish, as a background, information concerning the methods of production or manufacturing which have a bearing on consumption and the marketing machinery which brings the product from distant producing regions. Certain specific information concerning the product is needed such as: the chief producing regions; the volume of production; the peak of production; the season when available and when most abundant; varieties with quality; grades and the brands descriptive of such grades; standard packages with volume or weight; quality and value as distinct from appearance and price; and the special uses for which the product is suited.

The importance of definite information in regard to the season can be illustrated by cauliflower. Cauliflower, the variety *botrytis* of the cabbage group, is a plant requiring abundant moisture and cool temperature for the production of marketable stock. It shows a definite climatic response with the heaviest production in January, a lesser production in the Fall and Spring and a very small production in June, July and August. The intelligent placing of consumer demand is therefore very clear.

Spinach is another crop with clearly marked seasonal availability. The four chief producing regions are Texas, Virginia, Maryland and South Carolina, with Texas and Virginia the heaviest producers. The three winter months are the months of heavy production with no shipments in June, July and August. The ecological factor of temperature is well shown; spinach, heat intolerant, is produced in the winter in the truck gardens of Texas and the South Atlantic states. In the northern states, the summer season is

too hot for the production of spinach, and the period suitable in Spring and Autumn is too short to produce more than a small and uncertain supply. Spinach is, therefore, a vegetable to be used when most available, namely in January, February, March, rather than in June.

Materials of this nature the writer feels, would, if made more generally available help in developing a technique of consumption.

ANATOMY OF THE XYLEM OF *SCIADOPITYS*

BY

ALAN S. PEIRCE

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ABSTRACT

This investigation was undertaken with the intention of presenting a complete anatomical study of *Sciadopitys*, from which it is hoped new light may be thrown on its phylogenetic affinities. The anatomy is revealed as being quite simple, with but two notable exceptions: the absence of a resinous system is paralleled only in five species of *Abies*, and the absence of end-wall pitting in ray cells is not known in other conifers. The presence of resin canals and resin cells in tissues of the cone axis other than xylem suggests interesting corroboration of Jeffrey's theory concerning the evolution of these organs. Extremely primitive manifestations are found together with others equally advanced. Taking a phylogenetic view of the sum of anatomical characters, it is assumed that *Sciadopitys* is not closely related to any known conifers. Its evolution apparently involves somewhat remotely both the Abietineae and Taxodineae, but not the heterogeneous Cupressineae.

PERSISTENCE OF SUBSPECIFIC TYPES OF *XANTHIUM* IN THE FIELD

BY

CHARLES A. SHULL

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ABSTRACT

Attention is called to the unhappy situation in the taxonomy of the genus *Xanthium* caused by the disagreement between recent monographs on this group. Evidence is presented to show that some of the forms which are considered of sub-specific rank by the monographers are capable of maintaining themselves as distinct entities under field conditions.

The species described some years ago as *X. globosum* and included under this name in Millspaugh and Sherff's[1] monograph, was grown a number of years, and maintained itself as a distinct form. Widder[2] considers this species a form of *X. pungens*. Evidence in regard to variability in seed size in *X. globosum* and *X. pungens* indicates that the two are quite distinct. In length, breadth, and weight of seeds, color of seed coats, time of blooming, color and armature of burr these two are distinct enough to retain *X. globosum* as of species rank.

Another form of sub-specific rank, *X. chinense globuliforme*[3] has been maintaining itself under field conditions for six years, and seems capable of becoming an independent and permanent multiple seeded form of *Xanthium*. There has never been any apparent tendency for it to split up into other forms. It is very prolific, and all plants are fertile. Volunteer plants propagate it year after year without difficulty. In nature it could become a very persistent weed.

A third sub-specific type is *X. pennsylvanicum laciniatum*[4] which was discovered by the late Mr. Crevecoeur of Onaga, Kansas, several years ago. These laciniate forms have been maintaining themselves by volunteer propagation, and 100 per cent of the offspring came true to type in a test embracing nearly 400 individuals. There was no evidence of hybridization, and the laciniate type of leaf seems fixed in this form.

The origin of these sub-specific types is not known. They have arisen suddenly as if by mutation, although the multiple seeded form may be of hybrid origin. But they are apparently not any less stable than those forms that are regarded as true species, and can maintain themselves unaided in the field. Such forms raise the question as to what constitutes a species, and as to what constitutes good taxonomy, that which concerns itself only with dried herbarium specimens, often immature, or that which gathers evidence of stability and presistence in nature on the basis of breeding and field tests. Certainly those forms that cannot persist and remain stable in character should not be called species; those that arise in nature, which can and do persist, and remain permanently stable seem worthy of consideration as true species.

[1] Millspaugh, C. F., and Sherff, E. E., Revision of the North American species of the genus Xanthium. Field Museum of Natural History Pub. no. 204. 1919.

[2] Widder, F., Die Arten der Gattung Xanthium. Repertorium specierum novarum regni vegetabilis. Beih. Bd. XX Berlin. 1923.

[3] Millspaugh, F. C., and Sherff, E. E., Xanthium. North American Flora 33:37-44. 1922.

[4] Sherff, E. E., New or otherwise noteworthy Compositae. Bot. Gaz. 92:202-209. 1931. (See pp. 208-209.)

GRASSLAND IN THE FLOODPLAIN OF ILLINOIS RIVERS

BY

LEWIS M. TURNER

University of Arkansas, Fayetteville, Arkansas

The occurrence of grassland in the floodplain of the larger rivers in or bordering Illinois has been discussed by Brendel (1887), Gleasan (1910), Imlay (1797) and Sampson (1921). The relationship of this type of grassland to bottomland forest and other vegetation types in the Mississippi and Illinois river valleys seems to be as follows: the customary floodplain forest is commonly confined to a belt or zone from a few hundred yards to a half mile in width paralleling the river channel or surrounding ponds and lakes. The landward side of this forest type merges into a grass association, at first on the hydric side of mesophytism, but giving way in turn, as the elevation of the floodplain increases, to a mesic grass association.

Two such areas were studied in the summer of 1930, in the Mississippi floodplain near Hillview, and the Illinois River floodplain northeast of Kampsville. An analysis of the site factors of these situations did not reveal striking differences between these areas and similar prairie areas in the middle western states, except for occasional flooding.

The spring floral aspect of these areas is characterized by the early vegetative phase of the grasses and the few sedges that will later dominate the situation. In addition are a number of early blooming spring flowers as Cerastiums, Veronicas, Stellaria, Specularia, Amsonia, Ranunculus, Myosurus, Erigerons, Potentilla, Apocynum, Sisymbrium and Arabis. Two grasses, Alopecurus and Festuca are identifiable and Eleocharis is fairly common.

Midsummer finds the following plants important in the habitat: *Spartina Michauxiana*, Bidens species, Cassia, Ambrosias, Iva, Apocynum, Steironema, Vernonias, Oxalis and Euphorbias. By this time Spartina, *Panicum virgatum* and *Calamagrostis canadensis* have attained such size as to be the dominant, conspicuous plants.

A statistical survey, conducted in early September revealed the following floristic character of the prairie: *Spartina Michauxiana* is conspicuously dominant in both areas. *Panicim virgatum*, although having a spotted distribution is locally important to the point of dominance. *Elcocharis palustris* and Carex species are relatively important. Both areas have also a representation of dicotyledonous plants, as *Lythrum alatum*, *Cassia Chamaecrista*, *Bidens trichosperma*, *Ambrosia bidentata*, *Iva ciliata*, *Eupatorium serotinum*, and *Oxalis corniculatus*.

In many ways these areas resemble some of the stages in prairie succession as occurring in the Mississippi floodplain near Savanna, Illinois (Sampson, 1921). However, in this instance clear-cut steps in succession were not discernible, conversely there occurred an abundance of overlapping of stages.

The method of statistical analysis employed was that derived by Raunkiaer (Raunkiaer, 1918). The frequency curve of the areas in question essentially coincided with the curves derived by other investigators elsewhere. However, the results obtained more nearly approximated Kenoyer's curve

(Kenoyer, 1927) in the Chicago region, than other areas described by other investigators.

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PAPERS IN CHEMISTRY

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

The Chemistry and Physics sections held a joint session at which three lecture-table demonstrations and two papers were presented, after which the groups separated for their section meetings.

Of the eight papers on the Chemistry program, only five are here represented. The others were:

"Activity Coefficients of Hydrochloric Acid," and "Pressure in Bubbles," by T. F. Young, University of Chicago, Chicago, Illinois.

"The Value of Valence and When to Teach It," by E. E. Rademacher, Nokomis.

Mr. Fred A. Dykins, State Highway Division, Springfield, was elected chairman for 1933-34.

(Signed) GEORGE C. ASHMAN, *Chairman*

LECTURE TABLE DEMONSTRATIONS

BY

CHAS. T. KNIPP

University of Illinois, Urbana, Illinois

LIQUID OXYGEN

Abstract.—This paper has to do with the liquefaction of oxygen as a lecture table experiment. The apparatus consists of a single bulb (pyrex) and the operation need last but 30 seconds and yet results in the formation of 2 to 3 cc of liquid. The process may be projected on a screen.

A NEW EXPERIMENT SHOWING THAT CATHODE RAYS LEAVE THE CATHODE SURFACE NORMALLY

Abstract.—This fact is so well established that a suggestion of an experiment to show it seems trite. The cathode is a cylinder around which are placed a number of rings of wire equally spaced. These wires are conductors yet they cast distinct shadows on the walls of the discharge tube. The experiment is novel and at first perplexing yet easily understood. To make the phenomenon visible throughout the room the vessel is primed with helium.

A RECTIFIER HAVING COLD ELECTRODES

Abstract.—When one refers to rectifiers we at once think of discharge tubes having a hot cathode. This new rectifier makes use of the principle, established years ago by Hittorf, that in order for a current to pass through a discharge tube the electrodes must be so located that the Crookes dark space can form freely. By preventing this in the case of one of the electrodes, in a simple discharge tube, and placing this tube in series with the secondary of, say, a ½ kilowatt transformer, the resulting high potential alternating current may be rectified. Experiments showing an alternating and a rectified discharge through a vacuum tube will be performed.

THE MAGNETO-OPTIC METHOD OF ANALYSIS

BY

B. S. HOPKINS AND GORDON HUGHES

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ABSTRACT

The magneto-optic method of analysis which has been devised by Professor Fred Allison depends upon the fact that when a water solution of an inorganic salt is subjected to a magnetic field it rotates the plane of polarized light (Faraday effect). When the magnetic field is applied there is a brief time interval before the Faraday effect can be detected. The length of this lag depends on the nature of the material in solution. If it is possible to measure the extremely short spaces of time which represent the differences in the lag, then it ought to be possible to use these differences as a means of chemical analysis.

The apparatus includes a light source such as a metal spark. This light is polarized by a Nicol prism and passes through two tubes which are surrounded by oppositely wound coils of wire. Behind the second coil is placed another Nicol prism, the two prisms being "crossed" so that a minimum of light emerges at the zero position. The two tubes are filled with different liquids, and the second coil is moved a short distance away so that the light is compelled to travel a slightly longer path and hence delay for a fraction of a second the effect of the magnetic field. By careful adjustment the delay caused by the increased light path may be made to coincide with the Faraday lag and at this point a minimum of light emerges. By noting the position of these minima, it is found that each inorganic salt has a minimum for each of the isotopes of the metal. This apparatus is therefore a device for measuring the time required for light to travel a distance of a few millimeters.

The method is extremely sensitive since the minima persist even when the solution contains only a slight trace of solute. Roughly, it should be possible to detect a single drop of brine in 100,000 barrels of pure water.

It is to be expected that any method which is so extremely sensitive might easily mislead an observer. Accordingly results on the magneto-optic apparatus have been carefully checked against standard methods such as the arc spectra, the absorption spectra and X-ray spectra with satisfactory checks in every case. We believe that in the hands of a careful, well trained observer the method can be depended upon to give accurate results.

Its advantages are: (a) extremely small quantities can be detected; (b) complex mixtures can be analyzed without separating the constituent materials; (c) the analysis is possible with a minute sample; (d) there is almost no loss of material; (e) the apparatus is moderate in cost; (f) the method may be adapted within limits to both qualitative and quantitative work.

The great weakness in the method under present conditions is the uncertainty on the part of various observers in detecting the minima. If a photoelectric cell could be brought into use or a photographic record made the large personal equation would be eliminated and the method would find many useful applications.

A STUDY OF BOILER WATERS IN HIGH PRESSURE PLANTS*

BY

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University of Illinois, Urbana, Illinois

ABSTRACT

The occurrence of calcium sulfate scale in ordinary boiler operations, the common practice of treating the water in order to prevent the formation of this particular compound, and the conditions of its formation in the ordinary boiler operating at 250 pounds pressure is well known.

High pressure boilers up to 2,000 pounds pressure have been recently constructed in this country and abroad. The higher efficiency of operation has caused considerable interest in these particular plants. Unfortunately, no data are available on the solubility of calcium sulfate under the new conditions, the solubility of many other salts present in ordinary boiler waters, or the effect of one soluble salt on another. The problem of operation at these high temperatures and pressures becomes a serious one. Work was started in the Chemical Engineering Division at the University of Illinois some years ago in order to ascertain the solubility of all these salts under these new conditions, and the effect of one upon the other.

It is realized that scale formation under high temperature conditions is likely to materially retard heat transfer and cause a hot spot in the metal and the failure of the tube or drum due to the high pressure. Such failures are likely to be disastrous, not only from the standpoint of property damage but also from the standpoint of loss of life.

The preliminary results of these tests, as far as calcium sulfate scale is concerned, indicate that the use of a small amount of soda ash will prevent the formation of calcium sulfate scale at high temperatures and pressures, and at the same time sufficient sulfate ion can be maintained to prevent embrittlement of the boiler plate.

In conclusion, it may be said that solubility studies at high pressure and high temperature will not only be valuable from the standpoint of the power plant operator but should supply data which will be of real use to everyone who is attempting to remove salts from water solution and who can utilize both high pressure and high temperature.

* This work was done by Professor F. G. Straub of the Chemical Engineering Division, Engineering Experiment Station, University of Illinois. The work has had the financial support of the Utilities Research Commission Incorporated, of Chicago, Illinois. Further details of the work have been published in the Transactions of the American Society of Mechanical Engineers, *54*, (21) 221, Nov. 15, 1932.

EVALUATING A HIGH SCHOOL CHEMISTRY COURSE

BY

JOHN C. CHIDDIX

Normal Community High School, Normal, Illinois

Since the ultimate effect of the teaching upon the student is of most importance, the student's opinion of what is interesting and valuable in his general education should be considered.

To obtain the student's evaluation of what he studies, a questionnaire was prepared which listed 46 different learning elements, achievements and activities commonly included in the high school chemistry course. Each student in ten different high schools of cities having populations from 1000 to 100,000 was asked to judge each item as to whether it was interesting and as to whether it was of general educational value in later life.

Abstract ideas, it was found, are not interesting and are usually not recognized as of much value, especially if they are difficult to comprehend. For example, the theory of atomic structure and its relation to chemical activity was rated very low in both interest and educational value. How laws are derived was considered of interest by only 30 per cent and of educational value by 23 per cent of all the students. Determining the weight of a metal that would replace one gram of hydrogen ranked 32 per cent in interest and 42 per cent in educational value.

The data showed that what appealed most either applies to life directly, provides purposeful activity, or explains the nature of chemical activity. The students considered it very interesting and still more valuable to learn of the elements and compounds essential to plant and animal life, to learn of some of the chemical processes in the animal body, and to learn of the chemistry related to the home. Taking trips to local industries was considered very interesting by 94 per cent of all the students, and 89 per cent considered it of great educational value. Doing projects was interesting to 80 per cent of all the students, while 62 per cent thought it educationally valuable.

Learning that clarifies the nature of chemical action is also desired by students. For example, 68 per cent of the students were interested to know that when two elements were united chemically, the compound formed has entirely different properties from either of the two elements thus uniting, while 58 per cent believed it of educational value. Again, 74 per cent thought it was both interesting and valuable to know that matter cannot be destroyed, even by burning, but that it can be changed in form into a different substance.

The uses of the elements and compounds and the properties that make them useful appeal to the students of all the schools. The uses were rated as interesting by 75 per cent of the students and as educationally valuable by 87 per cent.

In the light of the above data the teacher should associate the necessary abstract material as closely as possible with actual problems of his students' experience. Learning elements can be made to appeal to students by presenting them through projects, studies of local industries, or other activities of interest to students.

SIRUP FROM JERUSALEM ARTICHOKES

BY

F. A. DYKINS AND D. T. ENGLIS

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ABSTRACT

Levulose, the finest and sweetest of all sugars, is available in polymerized form in the tubers of the Jerusalem artichoke (*Helianthus tuberosus*). The commercial development of levulose has been advocated both as a supplementary source of food and for the production of sugar in regions in which sucrose production is not permissible. The peculiar physical properties of levulose, its higher sweetening power and the distinct flavor will enable its use for purposes for which other sugar products are unfitted. The Jerusalem artichoke, being of a hardy nature, is adaptable to a wide variation of soil and climate and sometimes may serve as an important source of this sugar. This investigation had as its object the production of a palatable sirup from these tubers, the difficulties attendant to the crystallization procedure being reserved for future study.

The tubers, upon reaching maturity, are washed, sliced and dried, and the dried material is used for the preparation of the sirup. An extract is prepared by diffusion in the regular manner in a six cell diffusion battery. The principal scientific interest centers in the method of hydrolysis of the solution of the polysaccharide material. A study of various combinations of the reaction time, temperature, degree of acidity and concentration of solids in the extract was necessary before optimum conditions for the reaction could be established.

Following the experimental work in the laboratory, the process selected was adapted to a semi-plant scale. The operations are essentially as follows. The extract of 30–35 per cent total solids as obtained from the diffusion battery is filtered with the aid of Super Cel using a small Shriver filter press. It is then acidified with HCl to a pH of 4.2 and transferred to a copper converter having a capacity of about 40 gallons. Steam is introduced directly into the reaction mixture until a pressure of 25 lbs. is reached. This pressure is maintained for about 20 minutes after which the solution is blown off. The converted extract is transferred to a glass lined evaporating pan and concentrated under diminished pressure to 50–60 per cent solids. After withdrawal of the sirup from the pan, it is neutralized with sodium carbonate to a pH of 5.4 and then filtered through active char (carboraffin) to reduce the color. Finally it is evaporated in the vacuum pan to a solids content of about 82 per cent.

The resulting sirup has a color ranging from a light yellow to a dark reddish brown. The taste varies somewhat depending upon the character of the original dried material, the conditions of evaporation, and the extent of active char treatment. In the present form the product is recommended chiefly for table use and for cooking in which a colored sirup is permissible.

THE ELECTRODIALYTICAL PROCESS AS A METHOD FOR ACIDIFYING AND PURIFYING POLYSACCHARIDE SOLUTIONS

BY

V. R. HARDY

Department of Chemistry, University of Illinois, Urbana, Illinois

Research work having as its ultimate goal the preparation of a palatable syrup from the tuber of the Jerusalem artichoke (*Helianthus tuberosus*) has been in progress at the University of Illinois for several years. However, in the preparation of such a syrup two problems are of considerable importance: (1) the conversion of the polysaccharides contained in artichokes (inulin and various levulins) into simple sugars, and (2) the removal of undesirable non-sugar material which also occurs in the tuber.

Since certain difficulties are inherent in all of the conventional methods of solving these two problems, the possibility was investigated of accomplishing by one process both the acidification of the diffusion-battery extract obtained from artichokes, which acidification is necessary to effect conversion of the polysaccharides to simple sugars, and the removal of at least part of the non-sugar material in it. This process is based on the phenomenon of electrodialysis, which may be defined as the migration through diaphragms of ions under the influence of an electrical potential.

The extract containing, in addition to the polysaccharides, such salts as naturally occur in the artichoke tuber, was treated in an electrodialytic apparatus fitted with such diaphragms that an excess of the cations in the salts escaped. As a result an appreciable amount of water was ionized, the OH^- ions also migrating to the anode to equalize the positive charges carried to the cathode, and the H^+ ion concentration of the extract was increased. At the same time a considerable percentage of the colloidal material in the extract was discharged and coagulated. Therefore the procedure accomplished both the acidification of the extract and the removal of much of the inorganic salts and the organic colliodal material in it.

A series of investigations was carried out in which the independent variables, viz. rate of flow of extract through the process, current density, concentration of solid material in the extracts, and the nature of the diaphragms, were varied and their effect on the dependent variables was noted, viz. $[H^+]$ produced in the extract, colloidal material coagulated, and cost of the process.

The results obtained may be summarized in a few generalizations:

(1) The final pH of the extract depends chiefly upon the per cent of cations or of total ash removed from it.

(2) Increasing either the rate of flow of the extract, or its concentration, or both, while other variables are held constant decreases the $[H^+]$ produced.

(3) Increasing the current density while other variables are held constant increases the $[H^+]$ obtained.

(4) The current density is directly proportional to the rate of flow of the solution if other variables are held constant.

(5) If the $[H^+]$ to be produced in the extract remains constant and the rate of flow of the extract is increased its concentration must be decreased or the current density increased, or both.

(6) About 40 per cent of colloidal material is coagulated during the production of an extract with pH of 4.2, that required for conversion of the polysaccharides under the conditions of our work.

(7) At 2 cents per kilowatt hour the cost of current to produce this pH is 0.04 to 0.1 cent per pound of finished syrup.

(8) With less permeable diaphragms in the apparatus the final pH is only slightly higher than with more permeable ones.

HOW IMPORTANT IS THE TIME FACTOR IN EXAMINATIONS?

BY

J. H. SAMMIS

Peoria Central High School, Peoria, Illinois

The importance of the time factor in the successful completion of examinations is bound to vary with the type of test used. We are concerned here with the short completion, multiple choice, or true-and-false test given as part of the daily assignment in any class in science. Lack of time has so frequently been offered as the reason for failure to satisfactorily handle a test that the author for a period of over two months gave fifty tests to his classes, which were given with one minute by stop watch for each question, and then repeated with an additional one minute allowance per question, any changes or additions being made in different colored pencil.

The results were uniformly consistent. Doubling the time for answering succeeded in raising the average grades in every test given by less than 5 per cent. In many cases individuals actually lowered the grade made with the original one-minute allowance. Instances of lowering grades were particularly in evidence among pupils ranking consistently in the lower quartel of their classes.

In view of the fact that the beauty of the short daily test lies in the small amount of time it takes, it hardly seems advisable to give too much time for answering questions on tests of the type discussed, notwithstanding pupil alibis to the contrary.

WHAT SHALL WE DO ABOUT THAT CHAPTER ON PHOTOGRAPHY?

BY

J. H. SAMMIS

Peoria Central High School, Peoria, Illinois

In view of the fact that nearly every text book on general inorganic chemistry contains more material than can be satisfactorily covered in the prescribed time, some of the material must be omitted. In deciding what material to use we feel that those subjects or phases of a subject should be taught which are (1) most commonly used or encountered, (2) most interesting and successfully mastered, and (3) most closely correlated to other subject matter in the curriculum.

If those statements be true, the chapter on photography has been unjustly dealt with in many instances. Examples of photography are daily making up larger and larger portions of our newspapers, magazines, and books, and one must not overlook the fact that motion pictures are photographs.

Photography is surely as interesting and as easily mastered as an understanding of Charle's and Boyle's laws. The relationships between photography and physics (lenses, light, filters, depth of focus, metric system), art (composition, distribution of masses, elimination or emphasis of detail), chemistry (development, compounding of formulae, reduction, intensification, common ion effect), journalism (news stories, year book snapshots) and teaching (lantern slides, copied pictures) is too apparent to need further attention.

The acquisition of entertaining, helpful, or at least harmless hobbies is something we as teachers are urged to encourage. Photography seems to meet the requirements of a fascinating and not too costly a hobby. We feel that the chapter on photography should be taught, and possibly where circumstances and enthusiasms permit, emphasized.

PAPERS IN ECONOMICS

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

A symposium of four papers on "Problems of the Illinois Coal Industry," followed by a general discussion, comprised the program of the Economics Section.

The fourth article, "Competitive Position of Fuel Oil and Natural Gas with Coal in the St. Louis District," by C. V. Beck, President, Lumaghi Coal Company, St. Louis, is the only one not here represented.

No chairman was elected for the coming year.

(Signed) WALTER H. VOSKUIL, *Chairman*

COMPETITION OF APPALACHIAN COALS, FUEL OIL, NATURAL GAS AND OTHER FUELS WITH ILLINOIS COAL IN THE ILLINOIS COAL MARKET AREA

BY

W. H. VOSKUIL

State Geological Survey, Urbana, Illinois

ABSTRACT

Illinois supplies coal to seven states in the Upper Mississippi Valley. In this same area vast quantities of coal from West Virginia, Kentucky, and elsewhere, fuel oil from the crude petroleum supplies of the Mid-Continent field, and natural gas from Kansas and the Panhandle of Texas are also marketed. This Upper Mississippi Valley is a battle ground for competing fuels that originate in widely separated districts. Each fuel industry is equipped and prepared to supply a far greater quantity of fuel than the normal market of the area requires. Each fuel has been driven, by the keen competition for the market, into lower and lower price levels until a balance between costs of production and selling prices have been all but disregarded.

The boundaries of this territory, in which 90 per cent of the Illinois output is sold, have been determined by the competition of fuel oil and natural gas in the Southwest; the eastward movement of coal from Colorado, Wyoming and Montana into Kansas, Nebraska and the Dakotas; ex-lake coal in the shore counties of Minnesota and Wisconsin; and Indiana and Appalachian coals in the territory east of Illinois. Consumption of energy in the Illinois market territory in 1929—a year when the total Illinois output was 60,658,000 tons—is shown in the following table.

Summary of Energy Consumption in Illinois Market Area in 1929
(Gasoline Excluded)

	Quantity	Coal or Coal Equivalent, Tons
Bituminous coal, tons	102,858,155	102,858,155
Coke, tons	4,580,764	4,580,764
Briquets, tons	687,377	687,377
Anthracite, tons	2,705,946	2,705,946
Fuel oil, barrels	28,871,165	6,880,000
Natural gas, 1,000,000 cu. ft.	95,410,000	3,816,400
Water, power, 1,000,000 kw.-hr.	2,814,435	2,388,000

Low-cost transportation to lake territory offers a difficult problem for Illinois producers, but in the case of Appalachian coals, the preference engendered by the special qualities of some of these coals and the lower prevailing wages do not offer insuperable difficulties. The situation with respect to fuel oil may be expected to improve when the output of crude is controlled and the price raised sufficiently to make more cracking profitable. Markets in the states producing natural gas are becoming saturated, and future development means that outside outlets must be found, of which the Illinois market territory is the most important. Eventually these competitive interests must enter into closer cooperation to obtain for each a fair share of the market on the basis of scientific distribution.

ECONOMIC IMPORTANCE TO THE ILLINOIS COAL INDUSTRY OF THE MECHANICAL PREPARATION OF COAL

BY

D. R. MITCHELL* AND C. M. SMITH**

University of Illinois, Urbana, Illinois

ABSTRACT

Although the scientific preparation of coal is of fundamental economic importance to the coal industry of this State, it has been largely overlooked as a means of bettering the industry's status. However, an increasing demand on the part of consumers for cleaner and more closely sized coal is resulting in renewed interest in coal preparation.

The proportion of coal marketed in the larger and more profitable sizes has been declining for several years. In 1900, egg and lump coal constituted nearly 60 per cent of the State's output; whereas, in 1931 they made up only 40 per cent of it, the decline in the proportion of lump coal having been particularly severe. Correspondingly, the proportion of screenings rose from about 10 to 30 per cent.

Since screenings must frequently be sold at a loss the tremendous economic importance of their increased production is evident. One factor in the low price of screenings is that they normally carry a higher content of impurities than do the larger sizes of coal.

Although the mechanical cleaning of coal was once a major activity in Illinois, it declined almost to the vanishing point, following the World War. Within the past four years, however, there has been a pronounced increase in the amount of coal being cleaned mechanically. This is true in Indiana also, where more coal is being mechanically cleaned than in Illinois, although the Indiana production is less than one-half the Illinois production.

It is frequently asserted that Illinois has been losing its markets to eastern coals but analysis of coal shipments showed that, between January 1932 and January 1933, 80 per cent of the loss suffered by Illinois operators to competing producers was to Indiana and western Kentucky mines.

Coal from both of these districts is much like Illinois coal in composition, but the practice of mechanical cleaning has been growing rapidly in both states, and although price is probably the ruling factor, it seems clear that greater cleanliness and uniformity of product has aided these operators in invading Illinois' natural markets.

Contrary to the experience of the deep mines in Central and Southern Illinois, the output of some large strip mines in Northern Illinois has been increasing rapidly in recent years. In each case the product is either partly or wholly cleaned mechanically, and uniformity of output is assured by routine chemical analyses.

It is evident that the consumer satisfaction engendered by an acceptably clean coal of uniform ash and sulphur content has been a factor in enabling these mines to grow in the face of the depression. It is by fostering such consumer satisfaction that Illinois operators in general can hope to recapture their former markets. The scientific preparation of coal is a step in this direction.

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THE GROWTH OF COAL SHIPMENTS BY MOTOR TRUCK INTO ST. LOUIS AND ITS EFFECT ON THE TRANSPORTATION AND MINING INDUSTRIES

BY

FRANK T. TIRRE

Better Business Bureau, East St. Louis, Illinois

ABSTRACT

At the beginning of the practice of hauling coal from mines by truck, direct to consumers in St. Louis, the general trucking rate was $2.00 per ton. At this rate the railroads were not bothered or even concerned, as it made no inroads upon their tonnage, so to speak, but the individual trucker soon discovered that this rate would enable him not only a fair profit on the haul, but it also opened up an easy avenue for him to get into the coal business at a nominal cost regardless of the equipment he had; he advertised by telephone number, carried no stock on hand, securing his coal from nearby mines in Illinois and delivering direct to the consumer in quantities of from 1 to 8 tons at a very low figure, much less than the rail rate that dealers with yards and railroad switches must pay. Regular dealers must and do have to take care of public demands under any and all conditions while these individual truckers, sometimes called "Snow Birds", meet none of these obligations or requirements. They became so numerous that at the present time more than 1,200 are engaged in this particular line of transportation of coal into St. Louis.

While there is no means of accurately checking the total movement of coal at both sides of the Mississippi River, it is estimated that ⅓ of the total truck coal goes to points on the east side such as East St. Louis, Madison, Granite City, etc. Due to the fact that East side cities are closer to the mine a relatively larger amount per capita of truck coal goes to these communities. This estimate of ⅓ of the truck tonnage to East side communities and ⅔ to St. Louis, Mo., is arrived at after consultation with a number of large truck mines who agree, after an analysis of their records, that this division is approximately correct. It is therefore apparent that the total truck movement and consequent loss of rail tonnage is approximately as follows, during the period under observation in this analysis.

	Tonnage actually checked as coming across Free Bridge to St. Louis. Estimated as 2/3 of total movement.	1/3 estimated as going to East side communities.	Total estimated movement.
Feb. 9-10 (24 hours)	8,655	4,328	12,983
Feb. 10-11 (24 hours)	10,438	5,219	15,657
Feb. 11- (16 hours)	8,412	4,206	12,618
Feb. 12- (12 hours)	1,263	632	1,895
Feb. 13-14 (24 hours)	8,513	4,256	12,769
Feb. 14-15 (24 hours)	7,837	3,918	11,755
Total	45,118	22,559	67,677

From the above it is apparent that the total truck movement during this five day period was approximately 67,677 tons, which was lost to the railroad, and is the equivalent of 1504 forty-five ton cars.

The above gives a very accurate picture of how trucking is increasing to St. Louis, Missouri. The Free Bridge has been checked more or less periodically for the last eighteen months. Each check reveals a material increase over all preceding checks. The check made in November and December showed a peak movement of slightly over 6,000 tons a day. This check shows an increase over any preceding check of from a minimum of 30 per cent to a maximum of 70 per cent increase. It explodes completely the idea that trucks cannot successfully operate in bad weather. The first day of this check it was 3 below zero, one of the coldest days in recent years, and there was a large quantity of snow and ice on the roads.

The year 1930 is the last year in which accurate figures of the truck coal loadings, St. Clair and Madison County, Illinois, are available. During 1930 slightly over 900,000 tons were loaded into trucks. From the above figures, it will be seen that in a good week truck loadings now are running close to 90,000 tons a week total.

PAPERS IN GEOGRAPHY

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

Of the eight papers that comprised the program of the Geography Section, only four are here represented. The others were:

"Reconnaissance Traverse in Ontario Peninsula," by Charles C. Colby, University of Chicago, Chicago, Illinois.

"Father Nile and Egyptian Agriculture," by W. O. Blanchard," University of Illinois, Urbana, Illinois.

"Distribution of Fisheries of the North Atlantic," by Vellora Foster, Northwestern University, Evanston, Illinois.

"The Water Factor in the Geography of East St. Louis," by Lewis F. Thomas, Washington University, St. Louis, Missouri.

Attendance at the meeting was nineteen.

Mr. Alfred W. Kasel, Moline High School, Moline, Illinois, was elected chairman of the Geography Section for 1933–34.

(Signed) RUBY M. HARRIS, *Chairman*

PROBLEMS OF LAND UTILIZATION IN ANTRIM COUNTY, MICHIGAN

BY

HERBERT N. COWLES

Northwestern University, Evanston, Illinois

ABSTRACT

Antrim County is situated on the east shore of Grand Traverse Bay, which is an arm of Lake Michigan located in the northwestern part of the lower peninsula of Michigan.

The topographic features of Antrim County, glacial in origin, may be classified into four physiographic provinces: (1) The lake benches and valley flats which border the inland lakes and extend into the interior valleys; (2) the rolling uplands, or rolling hills that occupy the high areas of the western townships; (3) the hilly uplands, which are the high recessional moraines of the central townships; and (4) the high plains, which are the barren outwash plains of the southeastern townships.

Antrim County was originally covered with excellent stands of hardwood forest along with a little white pine. The western part of the county has been cleared for about eighty years and is now farmland of relatively good quality.

The central and eastern parts of the county have been cleared of virgin timber and are now covered with a dense second growth of hardwood. These sections are poorly suited for agriculture but the second growth should be of value when mature.

The manufacturing industry has practically ceased to exist with the decline of the lumber industry. One large lumber, iron, and chemical plant is now in operation.

Recreation has become of major importance in Antrim County, where a splendid chain of lakes, numerous streams, large forested areas, a favorable summer climate, and ready access give this area unusual advantages. While resort development is fairly extensive along some of the lakes, no lake has approached its potential development. Hunting is apparently the one use for which the wastelands of the southeastern townships are suitable. The value of these lands for recreation will be increased when they are better stocked with game, and when the fire hazard is reduced.

Much of the area of Antrim County which formerly was utilized for lumbering or other industrial purposes is now utilized for recreation. The loss of population following the exhaustion of the forest resources is made up in part by the annual influx of tourists and resorters during the summer. Farms which once supplied forest and industrial workers with food products, now supply summer visitors with fresh garden, orchard, dairy, and poultry products, thus supplementing the income from crops. Taxes paid by owners of summer homes make up in part for the taxes once paid by industry. The problem of land utilization, arising from the loss of the most important resource of the county, the forests, may be met, in part, by the development of the recreational resources along with specialization of agriculture to meet the particular demands.

THE APPLE INDUSTRY OF CALHOUN COUNTY

BY

ALFRED W. KASEL

Moline High School, Moline, Illinois

Calhoun County, located in western Illinois, has achieved an outstanding position among the counties of the state in the production of apples. The county at present (1933) produces approximately a third of the commercial apple crop of the state. The average annual commercial apple crop in the county for the past eleven years has been approximately 422,000 barrels. In 1930 it exceeded 600,000 barrels.[1]

Significant changes in the marketing of Calhoun County's immense crop of apples have come about within the past decade. Chief among these changes are the improvement of facilities for transporting the apples to market, the rise of Chicago as a major market comparable with St. Louis, the advent of the itinerant trucker, and the improvement of facilities for the wholesaling of apples by commission firms in St. Louis.

Nearly all of the county's apples prior to 1925 were carried to the St. Louis market or to railway loading points by river craft. Since 1931 none have been carried by this method. Improvement of railway facilities and highways, the construction of a vehicle bridge across the Illinois River at Hardin in 1931, and the increased use of the motor truck have been the major adjustments which eliminated river craft as a means for transporting the apples.

The need for better facilities than river craft afforded became acute with the ever increasing volume of apples shipped from the county after 1910 and also by a demand on the part of apple buyers for a better quality of produce. The improvement of rail facilities in 1924 accomplished by the extension of a branch of the Alton Railroad from Titus to East Hardin ushered in a new era for the apple shippers of Calhoun County. The building of this railroad was the principal factor in making Chicago a major market for Calhoun County apples comparable with St. Louis.

The motor truck has become a major means of transporting the apple crop to the market centers within the past several years, mainly because of the improvement of Illinois highways. The use of the motor truck is a distinct advantage to the industry.

In the summer of 1932 the facilities for the wholesaling of apples by St. Louis commission firms were greatly improved through the establishment of the St. Louis Apple Exchange. The exchange was organized for the purpose of combining the receipts of apples in one central location in order to serve the interests of the grower, shipper, and buyer.

Although the previously described changes have meant an improvement in the former inefficient methods of marketing the apples, there are a number of problems remaining to be solved before Calhoun County can be said to have a really efficient system of marketing. The problems are concerned with an expected large increase in production within the next decade, standardization of pack, successful advertising, development of the by-product industry, improvement of roads within the county, and the development of a successful cooperative marketing organization to help solve the problems connected with the before mentioned factors.

[1] Data from Illinois State Department of Agriculture.

THE LAND UTILIZATION OF TOWANDA TOWNSHIP McLEAN COUNTY, ILLINOIS

BY

MARGARET MEANS

Bloomington, Illinois

Towanda Township is located in the central part of McLean County, Illinois. It is a congressional township, six miles square. The first settlers came between 1840 and 1850. The early occupations were typical of other agricultural communities of the open prairies. The first settlements were made in the groves where fuel, water, shade and shelter were found.

Cattle raising was introduced in the first decade of settlement. After the Civil War a more scientific agriculture was introduced, including a rotation of crops, especially corn, oats and wheat, and livestock production, including hogs, cattle and sheep.

The topography of Towanda Township is that of a gently rolling prairie with very little variation of relief, brought about mainly by the formation of glacial moraines and stream erosion. The main drainage system is that of Money Creek.

Soils are largely loessial in character. The upland prairie soils comprise about 95 per cent of the area. They are rich in organic matter and were covered originally with wild prairie grasses.

The native vegetation consists of forest and grasslands. The forests covered but a small portion of the total area and were found mainly along the stream valleys. Much of the prairie land was wet and marshy with coarse high grass. On the uplands the grass was short and wiry.

The climate is continental in character with cold winters and warm summers. The growing season is approximately 173 days. The precipitation averages 37.41 inches per year, well distributed for the growing of crops.

The early settlers of Towanda Township came from Indiana, Ohio, Virginia and Kentucky. Settlements were first made along the streams and then on the open prairie. The population is almost entirely native born and has been chiefly rural since the first settlement to the present time.

Two railroads cross the township and excellent concrete highways cross various parts of the area.

The city of Bloomington furnishes a good local market for agricultural and dairy products while Chicago is the chief grain and hog market.

At the present time corn occupies 50 to 60 per cent of the cultivated area with oats, hay, barley, soybeans and wheat occupying the remaining acreage.

There were 126 farms in Towanda Township in 1928 with an average size of 184 acres. At the present time there is no woodland whatever in the township; 81.4 per cent is in crops, and 18.6 per cent is in pasture.

Farm facilities such as tractors, telephones, automobiles, furnaces, radios and running water, are common throughout the township. The farm homes are well built and well kept. The rural schools are better than the average.

The animal distribution shows that hogs are becoming important, that cattle feeding is not profitable, that sheep show a notable increase, that the work usually done by horses and mules is being carried on by machinery, and that poultry raising is important.

A large percentage of the land is still held by descendants of the original owners. The farmsteads are attractive and well equipped.

Towanda Township is a typical well developed region of the Corn Belt and it represents a well-to-do community in the open country.

A CHILEAN VINEYARD

BY

ROBERT S. PLATT

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ABSTRACT

The Viña Conchalí is in the heart of Chile in the Central Valley. The district is semiarid and development depends largely on water for irrigation provided by streams from the high Andes. A share of the water diverted from the Rio Mapocho above Santiago and carried in a canal along the valley side is delivered to the Viña Conchalí at the upper edge of the property and thence distributed in a carefully laid out system of ditches reaching every field.

The size of the property is 275 acres, of which 100 acres are in steep slopes of the mountain foot and 175 acres are in the valley plain.

In this setting the owners have developed a high grade wine vineyard. The valley land of alluvial silt, deep and fertile, well drained and well watered, is divided by ditches and roads into 40 fields, practically all occupied by vines. The slope land is unimportant, being given over mainly to untilled pasture. In addition there are small patches of subsistence crops distributed along the base of the slope and along the main road near laborer's dwellings.

There are 26 small houses in which live the fixed inhabitants of the estate, Chileans of mixed white and Indian blood. The Chilean proprietors of the vineyard do not live on the property. The principal house is occupied by the manager, a Frenchman skilled in wine production.

The wine making establishment is at the main transportation focus of the estate, a location reflecting the need for immediate treatment of the perishable crop and also the incentive to nearby reduction of the bulky fruit to a more compact product. After a period of seasoning in storage vats the product is transported by truck to a warehouse in Santiago whence it is distributed to the Chilean market. The functioning of the whole establishment moves in the annual cycle of grapes and wine.

The Viña Conchalí is typical of one sort of development in central Chile. In addition there are grain farms, livestock farms and fruit orchards. These all are in contrast with rural establishments in other parts of Chile—unirrigated farms of the forest region a little farther south and subtropical oases few and far between in the desert regions to the north.

PAPERS IN GEOLOGY

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

All of the papers given before the meeting of the Geology Section are here represented.

Average attendance at the meeting was forty-five, maximum was fifty-five.

Mr. Charles H. Behre, Northwestern University, Evanston, Illinois, was elected chairman for 1933–34.

(Signed) J. E. LAMAR, *Chairman*

SOME PENNSYLVANIAN LIMESTONES OF THE CARLINVILLE QUADRANGLE, ILLINOIS *

BY

JOHN R. BALL

Northwestern University, Evanston, Illinois

ABSTRACT

The Carlinville quadrangle is in the southwest part of Illinois about 40 miles north of East St. Louis. The rocks of Pennsylvania age underlying the surficial deposits are chiefly shales and clays which disintegrate readily. Associated with them, however, are several limestones resistant enough to make ledges across the stream channels, and to make rock terraces in some of the valleys.

The limestones and their associated rocks belong to the McLeansboro series of the Pennsylvanian system. The aggregate thickness of the exposed part of the McLeansboro series is slightly over 100 feet. At least seven limestones of this sequence may be recognized quite readily. A few other instances of limestone outcrop, somewhat isolated, are known, and may prove to be different occurrences from those now recognized. The names of a few of the more important limestones follow, beginning with the oldest rock of the list: Shoal Creek limestone, Centralia limestone, Macoupin and Upper Macoupin limestones, and the LaSalle limestone.

Of this list the Shoal Creek limestone probably possesses the greatest amount of historical interest. On account of its frequent exposures in the vicinity of the city of Carlinville it has been called the "Carlinville" limestone. In all probability it has been confused with other limestones, both in the Carlinville quadrangle, and in other parts of the State. It is quite readily distinguished from other limestones of the quadrangle by its common occurrence in two prominent ledges, the upper one thicker and more massive and separated from the lower ledge by about 8 inches of dark shale. With the exception of the LaSalle limestone it is one of the thickest limestones in the quadrangle, and, with its lower member, attains an aggregate thickness of from 6 to 8 feet. In the vicinity of Carlinville it generally underlies other rocks of the McLeansboro series, but near Palmyra, in the northwest part of the quadrangle, it generally occurs as the uppermost of the Pennsylvanian rocks. This is due to the gradual inclination of all the Pennsylvanian rocks, the dip following a general southeast direction.

The Centralia limestone, lying in a stratigraphic position about 17 feet above the Shoal Creek limestone, and the Macoupin limestone, at about the same interval above the Centralia, are both quite distinct lithologically from the Shoal Creek. These two limestones resemble each other very closely, however. In some of the earlier geologic literature describing the rocks of this part of the State, occur references that imply some confusion in identity between the Centralia and Shoal Creek limestones, also. The Centralia limestone is one of the more fossiliferous rocks of the quadrangle and contains numerous brachiopods of common Pennsylvanian types. In color, texture, and in its habit of weathering, the Macoupin limestone resembles the Centralia quite closely. It may be distinguished, however, by its abundant fauna.

The LaSalle limestone is a prominent limestone. In the southeast part of the quadrangle, due to the structural attitude mentioned above, it becomes the capping rock of the McLeansboro series as far as represented in the outcrops. It is thicker, locally, than the Shoal Creek limestone, and is responsible for faintly developed rock terraces east of Carlinville.

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THE MICROGRAPHY OF THE LEAD AND ZINC ORES OF THE UPPER MISSISSIPPI VALLEY

BY

A. F. BANFIELD

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ABSTRACT

Study of the Upper Mississippi Valley lead and zinc ores by means of the reflecting polarizing microscope leads to the following conclusions regarding their paragenesis.

The ore minerals—barite, calcite, galena, marcasite, pyrite and sphalerite —indicate deposition under low pressures and at temperatures less than the boiling point of water. No diagnostic minerals occur which prove or disprove any of the known theories of origin, but the association of marcasite and pyrite indicates that the ore solutions varied from acid to alkaline or neutral, for pyrite is generally deposited from alkaline or neutral solutions at all temperatures while marcasite is deposited from acid solutions and at low temperatures. Paragenesis of the ore minerals is as follows: (1) Pyrite was deposited first, in considerable abundance and over a long period of time. While marcastie has been considered the common iron sulphide in the past, pyrite being thought quite rare, the author's studies show that pyrite is almost as abundant as marcasite, solution and dolomitization of the Galena dolomite, which preceded ore deposition, made the country rock porous and enabled ore solutions to percolate through it and deposit pyrite, mainly by replacement, as small isolated crystals. The amount of pyrite so disseminated decreases gradually away from the fractures along which ore solutions traveled. At the point of pyrite deposition the ore solutions must have been alkaline or neutral although they may originally have been acid, the acidity being reduced by their reaction with the calcareous country rock. (2) Marcasite was deposited next as a thin band lining fractures. Its contact with pyrite forms a sharp line of demarkation while its upper surface consists almost entirely of crystal faces. The change from pyrite deposition to marcasite deposition was caused either by increased acidity of the ore solutions, or by their reaction with the wall rock being prevented by the coating of pyrite. (3) Sphalerite was deposited on the well defined crystal terminations of marcasite. Near the end of its deposition sphalerite was accompanied by galena, calcite, and soft, greenish botryoidal masses of pyrite and marcasite. (4) Galena was deposited with and after sphalerite, erratically in the flats and pitches and abundantly in the crevices. (5) Calcite commonly occupies the center of flats and pitches and hence is younger than the above minerals. It occurs in two forms—an older rhombohedral and a younger scalenohedral. (6) Barite is rare but where seen is apparently the last mineral deposited.

Summary. The ore minerals of the Upper Mississippi Valley lead and zinc deposits were laid down in the following order: (1) pyrite disseminated in country rock; (2) pyrite along fractures; (3) marcasite along fractures and to a much lesser extent disseminated in the country rock; (4) sphalerite alone; (5) sphalerite with soft greenish botryoidal iron sulphides, galena and calcite; (6) galena; (7) calcite in rare early rhombohedral forms and abundant later scalenohedral forms; (8) barite. The relation between stages 5, 6, and 7 is gradational.

THE ORIGIN AND ECONOMIC IMPORTANCE OF BEDDING PLANE MOVEMENTS

BY

CHARLES H. BEHRE, JR.

Northwestern University, Evanston, Illinois

The term "fault" is restricted in practice to such movements only as take place in planes at sufficient angle to the bedding to produce noteworthy offsets. On account of their difficulty of recognition, movements parallel to the bedding or nearly so are largely neglected, yet they are mechanically necessary under many structural conditions.

In the case of parallel folds, gliding on bedding planes necessarily results if the folding is at all measurable. The famous Bendigo saddle reefs are clearly related to such movements. In folding produced by lateral compression bedding plane movements pass upward along the limbs of the folds until they come near the anticlinal crest, where load and support from below are lessened; here on the crests they tend to pass into recognizable reverse faults—the obvious results of thrusting. Such larger movements are frequently accompanied by smaller fractures which allow internal adjustments within the hanging- and foot-walls. Such fractures are reported from numerous mining districts.

Most larger thrust faults are either nearly horizontal, in which case they are commonly almost parallel to the bedding planes, as in the Wisconsin-Illinois lead-zinc district (where the movements are small), or the fault plane curves so that the angle of dip varies as the surface is approached. It is shown diagrammatically that such a curvature tends to result in openings of considerable width along the major fault plane. These openings afford means for the ingress of solutions; hence in part the common occurrence of mineralization in lens-like masses along the dip of the plane, forming at least some of the familiar "ore shoots" of such districts as Grass Valley, California, and Leadville, Colorado. Moreover small faults whose planes intersect the major thrust at sharp angles represent a mode of adjustment by the underlying and overlying rock masses, permitting the partial "chinking-in" of lenticular openings like those mentioned. Minor faults of this origin also afford means of ingress for mineralizing solutions.

Finally, where the major fault plane is curved, as mentioned above, and intersects the bedding at a steep angle, the strata cut by the fault are put under varying horizontal stress by the shift in the bulge on the opposite rock wall. Under such conditions those beds which project farther into the fault plane than others tend to be pressed back, away from the fault. Thus again movement along bedding planes is set up.

Several faults which have been carefully studied in ground plan or vertical section or both are cited as illustrations, the examples selected being partly from the published literature, partly from the writer's experience. Their bearing on mineralization and mining problems is discussed and the conclusion is drawn that many ore deposits are definitely related to faults of the types mentioned in which the movement is essentially along bedding planes.

CLEATING IN COAL

BY

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Cleating in bituminous coal has been observed for many years in districts where it has a marked influence upon the mining of coal although in other states such as Illinois it has been passed by unnoticed. Although most pronounced in bituminous coals, it does not seem to be a criterion of rank since it may be observed in all coals ranging from lignite through bituminous; anthracite however exhibits columnar structure. Reger and Behre in West Virginia and Pennsylvania came to the conclusion that the average strike direction of the principal cleating paralleled the local structure which in turn paralleled the principal ranges of the Appalachians.

In order to determine the persistence of the strike direction of cleating in Illinois coals, numerous readings were taken at various points. In Perry county, three miles south of Pinckneyville, the cleating in the No. 6 coal fell into two systems, N. 7°–37° W. and N. 52°–55° E. The limestone overlying the coal showed jointing in two series as follows, N. 16°–39° W. and N. 55°–65° E. At Pyatts the same coal possessed three cleat systems, (1) N. 45°–59° E., (2) N. 5°–35° W., and (3) N. 84°–85° E. Ten miles southeast at Hallidayboro, the coal showed three systems of cleats, one direction being less prominent than the others. These are listed as follows:

N. 35°–70° W.; N. 10°–19° W.; and N. 30°–40° E. (least prominent). Here as at Pinckneyville the overlying limestone was jointed in two directions, N. 53°–73° E. and N. 7°–23° W. Two miles north of Marion the same coal showed well developed cleat in a direction of N. 30°–40° W. and a poorly marked one N. 15°–38° E. Along the LaSalle anticline, at Lowell, strike directions of cleats were N. 46°–48° E. and N. 33°–55° W., while jointing in the non-carbonaceous material was exceedingly prominent in the following two systems, N. 35°–47° W. and N. 46°–55° E.

At all points of observation jointing in the non-carbonaceous strata paralleled cleating, and the prominent direction of jointing was always the strike of the pronounced cleat. It was further apparent that cleating was more pronounced along the axes of anticlines and became less marked away from the folds. Such observations are in direct accord with the conclusions of Behre and Reger for the Appalachian district. It is believed therefore, that jointing in sedimentary strata and cleating in coal are closely related, being formed contemporaneously by the same tectonic stresses rather than the result of processes of drying or coalification.

SUBSURFACE GEOLOGY IN THE EAST ST. LOUIS REGION *

BY

GEORGE E. EKBLAW AND L. E. WORKMAN

Illinois State Geological Survey, Urbana, Illinois

A study of available sets of sample cuttings from many of the deep wells in the vicinity of East St. Louis reveals some interesting problems.

The strata dip generally northerly and easterly, successively higher formations are encountered at the surface, and each outcropping formation increases in thickness away from the Ozark anticline. Pennsylvanian strata thicken rapidly in Illinois but occur only locally in Missouri. There is a marked unconformity at the base of the Pennsylvanian system. Chester strata, absent in Missouri but almost everywhere present in Illinois, thicken rapidly from west to east and from northwest to southeast, overlying the Ste. Genevieve formation unconformably. The St. Louis formation has a fairly uniform thickness, ranging from 250 to 300 feet. In Missouri it is thinner owing to surficial erosion but in Illinois it has its full thickness and is overlain conformably by the Ste. Genevieve formation whose thickness varies according to its location relative to the regional structure. It appears that to the west the St. Louis formation overlaps the older Salem and Warsaw formations, but the data are too scanty to assure the relations.

The Salem and Warsaw formations are fairly uniform but are slightly thinner to the north and east. The Keokuk-Burlington formations are also fairly uniform although they are appreciably thicker north and west than east of Mississippi River and south of East St. Louis. The Fern Glen formation is of uniform thickness in the East St. Louis region. It thins out and disappears to the west and is also lacking a short distance north and west of Alton, due probably to non-deposition. The Kinderhook series is thin everywhere and is sometimes absent in the East St. Louis region but it thickens appreciably to the north.

The combined Devonian and Silurian systems are absent in the west and their thickening to 500 feet in the east is a noteworthy feature. Most of this thickening is in the Silurian system which consists of a lower gray limestone, a middle "red rock", and an upper gray shaly limestone. These formations successively appear from west to east, showing that there is an important angular unconformity between the Devonian and Silurian systems. The Devonian system thickens from a few feet in the west to as much as fifty feet in the east. The Maquoketa formation is fairly uniform in thickness although it has some regular variations. It thins to the west, probably as a result of the same erosion that terminated the Silurian formations. The Kimmswick, Decorah, Plattin, and Joachim formations may be considered as a single unit that thickens slightly to the east. The St. Peter formation is fairly uniform in thickness although irregularities would not be unexpected. The Prairie du Chien series, consisting of the Powell, Cotter, and Jefferson City formations, and the Roubidoux formation are encountered in several wells but show no marked variations. Formations below the Roubidoux have been encountered in but few wells.

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STUDY OF THE INTERVAL BETWEEN COAL NO. 6 AND THE SHOAL CREEK LIMESTONE *

BY

M. W. FULLER

Illinois State Geological Survey, Urbana, Illinois

Stratigraphic studies of Pennsylvanian cyclothems in Illinois have shown that thicknesses of the individual cythothems vary considerably in different parts of the basin. This variation has resulted from two factors, (1) proximity to source area of sediments, and (2) differential warping during Pennsylvanian time, generally along preëxisting axes.

In general, cyclothems increase in thickness toward the southeast. This is particularly true of the sandstone and sandy shale members. Coals increase in number because of the wedging in of many new cyclothems toward the source area. Underclays and marine beds, however, generally increase in thickness toward the north and west.

In studying the general thickening of Pennsylvanian sediments to the southeast, two persistent, easily recognizable beds, coal No. 6 and the Shoal Creek limestone, were chosen and the interval between them was determined at as many points as possible. From these data an isopachous contour map was prepared. This shows a decrease in interval over known anticlinal structures and an increase in interval over known synclinal structures.

This interval has a minimum thickness of 83 feet in northwest Macoupin County on the flank of a nose of the old Ozark dome which during Pennsylvanian time was much more stable than the progressively subsiding basin. Here six cycles are represented between coal No. 6 and the Shoal Creek limestone. Several lack their sandstone, coal, and shale members. The interval is greatest in east central White County in the deepest part of the basin where 708 feet of strata are present between the datum planes and about 14 cyclothems are represented.

The most important structure in Illinois that affected Pennsylvanian sedimentation was the DuQuoin anticline. This structure was initiated at the close of Mississippian time and differential warping continued throughout the Pennsylvanian period. The interval between coal No. 6 and the Shoal Creek limestone increases markedly east of the anticline as the result of the wedging in of many new cyclothems and the thickening of clastic members of the persistent ones. The effect of the LaSalle anticline on Pennsylvanian sedimentation is less well known but was probably similar, as several sandstones wedge out on the flanks of the structure, making traps for oil and gas.

In northeast Madison County and adjacent parts of Montgomery and Bond counties there is a decrease in interval which marks the crests of the New Douglass dome and Panama anticline. In the southwest part of Marion County and adjacent parts of Clinton and Washington counties there is a decrease in interval which seems to be closely related to the structures from which oil and gas are obtained.

Because this isopachous map shows a decreased interval over known anticlinal areas, it is possible that this method of mapping will reveal previously unknown structures which might yield oil or gas.

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OUR PRESENT KNOWLEDGE OF AMERICAN COAL BALL PLANTS

BY

A. C. NOÉ

University of Chicago and Illinois State Geological Survey

The investigation during the past year centered about the coal balls collected in the old strip mine at Calhoun, Richland County, which has yielded much excellent material.

During previous years it was primarily the material from Harrisburg and Danville which was examined and of which preparations and microphotographs were made. As a rule, coal balls from only one locality are examined at a time in the paleobotanical laboratory of the University of Chicago where the coal ball studies for the Illinois State Geological Survey are carried out.

About 240 Calhoun coal balls were cut of which a number were sectioned and studied in detail. A research student, Mr. Roy Graham, used some of this material for the preparation of a dissertation on which he is to receive his doctor's degree at the 1933 June Convocation of the University of Chicago.

Of particular interest is the fact that the Calhoun coal is one of the youngest in the State, being of McLeansboro age. Worthen classified it as No. 13 or 14, the Harrisburg coal as No. 5, and the Danville coal as No. 7. The impending reclassification of Illinois coals according to cyclothems will undoubtedly give other numbers but their relative positions will not be materially changed.

The fossil plants found in Calhoun coal include a number of species of Calamites, Sphenophyllum, Lepidophloios, Lepidodendron, various ferns, such as Anachoropteris, Botryopteris, Corynepteris, Scolecopteris, Ptychocarpus, Cyathotrachus, Psaronius, a new fern genus, Sphaerotheca, a number of Cydofilicales such as Heterangium, Telangium, Conostoma, as well as a Gymnosperm, Cordaites.

The time-saving cellulose peel method has been used almost exclusively in preference to cutting individual coal ball sections and grinding them down to microscopic thinness. After the coal ball is cut in two or more portions and has been found to contain valuable information, its cut surface is smoothed. Afterward this surface is etched with diluted hydrochloric acid which removes a thin layer of the limestone matrix but leaves all organic enclosures intact. A solution of cellulose acetate in acetone or of parlodion in equal parts of absolute alcohol and ether is poured on and left to dry until a solid film forms. This film, which is easily removed, contains the organic particles in exactly the same position which they held while imbedded in limestone. In other words, we have a very thin section where calcium has been replaced by cellulose. This method has been improved by Mr. Graham, who used nitro-cellulose dissolved in butyl acetate (see "Stain Technology," April, 1933 for more complete report). In microphotographs prepared from such cellulose peels, the minute spores show extremely well, even at a magnification of 1,000 diameters.

The floras of all Illinois coal balls so far investigated can be correlated with the fossil plants of the Stephanian group of the Upper Carboniferous period in England and the continent.

THE CHERT OF THE NIAGARA SERIES OF THE CHICAGO AREA

BY

JOHN R. SCHULTZ

Northwestern University, Evanston, Illinois

The chert of the Niagara series in the Chicago area shows the following field relationships, which are believed to be diagnostic:

(1) Many of the chert bands branch laterally into two.

(2) Many nodules show finger-like projections which penetrate the wall rock at right angles to the bedding.

(3) Several steeply inclined layers or "feeders" of chert, which connect above and below with nearly horizontal bands, were observed in the Joliet quarry.

Other important features, but of less diagnostic value, are (a) silicified fossils in the chert and wall rock, (b) irregular inclusions of wall rock in the centers of many nodules, (c) silicification along joints and bedding planes, (d) distribution of the chert along bedding planes and along the tops of shale intercalations, and (e) arching of shale stratification around chert nodules.

It is thought that the chert has originated through segregation of siliceous material from out of the Devonian shales which formerly covered the area, and in part from the finely divided siliceous matter originally present in the Niagaran series itself. The agent effecting the segregation was, in all probability, circulating ground water. Colloform structures in the chert indicate that the silica was carried in solution as a colloid, and was precipitated by reaction with the carbonate wall rock.

Microscopic evidence indicates that the silica was originally precipitated as a gel, which later crystallized into various forms of hydrated, crystalline silica, later recrystallization of which converted a part of the mass into quartz.

The chert replaced, and to a smaller extent displaced, the surrounding wall rock. Cavity filling seems to have been relatively unimportant.

PENNSYLVANIAN ROCKS OF MADISON AND ST. CLAIR COUNTIES, ILLINOIS

BY

H. R. WANLESS

University of Illinois, Urbana, Illinois

Madison and St. Clair counties lie on the western edge of the Eastern Interior coal field. The contact of the Pennsylvanian and Mississippian systems crosses western St. Clair County and western Madison County, touching the Mississippi bluffs near Alton. It lies concealed beneath recent alluvial sediments in the American bottoms. A large outlier of the Eastern Interior coal field occurs in the eastern part of St. Louis County, Missouri. The succession of Pennsylvanian strata exposed in these counties ranges through the Pottsville, Carbondale, and lower McLeansboro formations or from the Babylon to Macoupin cyclothems of the classification introduced by the writer and J. M. Weller. The succession of strata in this district are abnormally thin, due to the influence of a weakly positive area along the eastern flank of the Ozarks which, during most of the Pennsylvanian period, stood above the profile of equilibrium and did not receive as thick accumulations of sediment as the trough to the east. The St. Louis area lay rather on the southwest edge of this Ozark flank, and its effect on sedimentation is even more pronounced northward, in Jersey, Greene, Pike, Calhoun, Brown and Adams counties. Southward from the St. Louis region, and even in the eastern parts of Madison and St. Clair counties, the section of strata thickens notably, and in southeastern Illinois the zone represented in these counties by less than 500 feet of sediments is represented by over 2000 feet. Shales, sandstones and coals are the strata which have thinned most notably in this area, and limestones and more or less refractory clays make a much larger portion of the section than elsewhere.

THE WARSAW FORMATION[1]

BY

J. MARVIN WELLER

Illinois State Geological Survey, Urbana, Illinois

Since Hall proposed the name Warsaw in 1857[2] for strata between the Keokuk and St. Louis limestones, the limits of this formation have been revised several times.[3] In 1908, Stuart Weller[4] correlated the upper eight feet of this formation at its type locality with the Salem limestone of Indiana and since that time it has been customary to recognize both the Warsaw and Salem formations in the Mississippi Valley. Because the Warsaw formation as thus restricted was considered equivalent to the Harrodsburg limestone of Indiana, the latter name has been abandoned.[5]

Practically all of the common Warsaw and Harrodsburg fossils are present in the Salem limestone of Indiana but in the Salem there also occurs a variety of small molluscs associated with innumerable shells of *Endothyra baileyi*. This is known as the Salem or Spergen Hill fauna and on its basis the Salem limestone was recognized in the Mississippi Valley. It is now known that this fauna is of no value for precise correlation but records a peculiar environment that existed at different times in different areas. It first appears in the Short Creek oölite at the base of the Warsaw formation in southwestern Missouri, and recurs in the Salem limestone of Indiana, in the so-called Salem of Ste. Genevieve County, Missouri (probably in part of lower St. Louis age), and in the Ste. Genevieve limestone at various places. Very similar forms occur in Chester and Pennsylvanian strata.

From Alton, Illinois, northward, beds referred to the Salem do not resemble the typical Salem limestone lithologically or faunally. Except for a small area in and adjoining southeastern Iowa where the so-called Salem is separated by an unconformity from the underlying Warsaw (restricted), there is no more basis for their differentiation than there would be for the recognition of the upper and lower divisions of the Warsaw (restricted) as distinct formations. It is doubtful that the so-called Salem-Warsaw (restricted) boundary in the Mississippi Valley is drawn at exactly the same horizon as the Salem-Harrodsburg boundary in Indiana or that the lithologic change at which the former is drawn occurs at even an approximately uniform horizon between Hancock and Monroe counties, Illinois. Because of these and other uncertainties it seems unfortunate that the Warsaw formation should have been restricted, thus causing the abandonment of such a well established name as Harrodsburg, particularly as it is impracticable to attempt any subdivision of these beds in some areas where a single name for this entire interval would be convenient.

It is proposed, therefore, to restore the Warsaw formation to its early status, assigning to it all beds between the Keokuk and St. Louis limestones as these are now limited. Where desirable the Warsaw formation may be subdivided into more or less local members.

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[1] Published with the permission of the Chief, Illinois State Geological Survey.

[2] Hall, James, Observations upon the Carboniferous limestone of the Mississippi Valley: Amer. Jour. Sci., ser. 2, Vol. 23, p. 193, 1857.

[3] Hall, James, Report on the Geological Survey of Iowa, Vol. 1, p. 97, 1858.
Weller, Stuart, The Salem limestone; Ill. Geol. Survey Bull. 8, p. 163, 1908.
Butts, Charles, Geology and mineral resources of Jefferson County, Kentucky: Kentucky Geol. Survey, ser. 4, Vol. 3, pt. 2, p. 157, 1915.
Van Tuyl, F. M., The stratigraphy of the Mississippian formations of Iowa: Iowa Geol. Survey Vol. 30, p. 185, 1925.

[4] Weller, Stuart, *Op. cit.*

[5] Butts, Charles, *Op. cit.*; Cummings, E. R., The nomenclature and description of the geological formations of Indiana: Indiana Dept. Cons., Pub. 21, p. 493, 1922.

THE STRATIGRAPHIC POSITION OF THE HOING SAND *

BY

L. E. WORKMAN

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The "Hoing sand" is a stratum of sandstone and sandy dolomite, that bears oil and gas in the Colmar-Plymouth Field of southwestern McDonough County in western Illinois. It was encountered at a depth of 417 feet in an oil test well on the J. Hoing farm and from this farm it received its name.

The "sand" varies from a porous, white to brown, quartz sand to a more or less porous, brown, sandy dolomite. The sand grains are of fine to medium size, apparently having been well rounded and frosted at the time of their deposition but now more or less coated with secondary crystalline quartz. The dolomitic sandstone and sandy dolomite have a matrix of brown dolomite crystals the size of silt. Scattered fragments of brown resinous *Sporangites huronense* are found in both the sandstone and sandy dolomite. The Hoing sand lies on a dark brown, highly bituminous shale of the Maquoketa formation and is overlain by brownish gray, coarsely granular to lithographic limestone in which sand grains of the Hoing sand type are common.

The Hoing sand was originally interpreted by Savage and Blatchley[1] as being of Devonian "Hamilton (?)" age, and the statement was made that the oil occurs "in a sandy limestone that is doubtfully identified with the lower part of the Devonian or the upper part of the Silurian systems." In later studies, after considerable drilling had been done in the field, Morse and Kay[2] definitely assigned the Hoing sand to the base of the Niagaran series. It was interpreted as "sand that was washed into the valleys and low areas when the Maquoketa shale was land surface and exposed to erosion," and that it was "reworked by the Niagaran sea."

Studies of numerous sets of sample well cuttings from Western Illinois bring out the following points regarding the stratigraphic relationships of the Hoing sand: (1) The unconformity at the base of the Silurian does not extend through the Maquoketa shale in this region and the Maquoketa does not have any sand grains of the Hoing sand type which might be left as a residual product of erosion to be concentrated by Silurian seas as the Hoing sand; (2) sand grains of this type are not found in the undoubted Silurian beds anywhere in this region; (3) there are no typical Silurian beds above the Hoing sand in the Colmar-Plymouth field; (4) sand grains of the Hoing sand type are characteristic of basal Devonian strata in this region and elsewhere in Illinois; (5) the Hoing sand in the Colmar-Plymouth field grades upward from porous sandstone into dolomitic sandstone and finally into sandy, dolomitic limestone of undoubted Devonian age; (6) the Hoing sand and the limestone beds above it contain *Sporangites huronense* common in Devonian strata; (7) the Hoing sand horizon is encountered in wells westward from the Colmar-Plymouth field where the Devonian unconformity successively overlaps Maquoketa and Kimmswick formations of Ordovician age.

It is therefore concluded that the Hoing sand is Devonian in age.

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* Published by permission of the Chief, State Geological Survey, Urbana, Illinois.

[1] Blatchley, R. S., "Plymouth Oil Field," Illinois State Geol. Survey Bull. 23, pp. 51-53, 1917 (Extract published 1914).

[2] Morse, W. C., and Kay, F. H., "The Area South of the Colmar Oil Field" and "The Colmar Oil Field—A Restudy," Ill. State Geol. Survey, Bull. 31, pp. 8-55, 1915.

PAPERS IN PHYSICS

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

The Physics Section held a joint session with the Chemistry Section for the first five papers (see Papers in Chemistry) after which the two groups separated. Six papers were given before the Physics Section, only four of which are here represented. Those not included are:

"Photoelectric Effect of Caesium Vapour," by Jacob Kunz, University of Illinois, Urbana, Illinois.

"An Electron-coupled Harmonic Amplifier," by David B. Chapman, University of Illinois, Urbana, Illinois.

Attendance at the meeting ranged from thirty to fifty.

Dr. Jacob Kunz, University of Illinois, was elected chairman for 1933-34.

(Signed) O. B. YOUNG, *Chairman*

INVESTIGATION OF CABLE INSULATION BY IONIZATION CHARACTERISTICS

METHODS OF DETECTION AND MEASUREMENT OF IONIZATION IN DIELECTRICS *

BY

J. TYKOCINSKI TYKOCINER

University of Illinois, Urbana, Illinois

SUMMARY

The results of the investigation on methods of detection and measurement of ionization in dielectrics may be summarized as follows:

(1) The assumption of the existence of surges and oscillations due to ionization in dielectrics has been experimentally verified.

(2) These oscillations were studied and utilized in the development of apparatus for detecting and measuring the relative intensity of ionization.

(3) Characteristic curves were obtained which correlate the applied voltage and the effective values of oscillations due to ionization. These curves make possible the study of the effect of applied voltage on certain properties of dielectrics and especially of cables.

(4) The existence of a time effect in connection with the intensity of oscillations due to ionization and the applied voltage has been ascertained.

(5) It was found that the time effect is characteristic of the quality of a cable in regard to impregnation and to a property which tends to shift the voltage at which copious ionization sets in.

(6) Ionization in a cable can be detected by radio-engineering methods, utilizing the electric impulses which ionization produces.

(7) A large range of frequencies was used in designing the apparatus. Frequency ranges as high as 30,000 kc. and as low as 100 kc. were tried and all gave similar results. Also audio-frequencies of about 2 to 5 kc. have been utilized in a great number of investigations on cables.

(8) The radio-frequency oscillations produced by ionization were utilized in three different ways. The first method was to amplify the magnitude of modulated radio-frequency currents and measure their effective values with thermoelectric and thermionic instruments. The second method was to apply intermediate detector action, and to measure amplified group frequency. The third method was to suppress the radio frequencies by rectification, and to select definite group frequencies for measurement.

(9) The utilization of lower group frequencies necessitated the use of special bridge arrangements for balancing the charging current. On the other hand the application of higher frequencies required special provision for guarding against interference from outside electromagnetic fields.

(10) The curves obtained with both types of apparatus are similar in character. They give the relation between the voltage applied to the cable and the intensity of the sum of the oscillations produced in a cable when ionization takes place.

(11) Both types of surge-measuring apparatus indicate the existence of bubbles and airpockets in a cable, if provision is made to prevent discharges taking place in transformers, condensers, and other parts of the circuits connected with the cable. They may thus be used as impregnation-testing apparatus.

* Published in full in University of Illinois Engineering Experiment Station Bull. 259, 1933.

(12) An application was made of the radio-frequency method to the testing of samples of paper moving between rotating nickel electrodes in air. Characteristic curves were obtained showing that the voltage at which corona discharge sets in, and the relative effective values of oscillations produced, are indicative of the character of the surface and texture of the paper.

(13) Methods have been devised for locating sources of ionization in cables. The underlying principles were verified by a number of experiments. Their applicability for testing of cables, however, was found to be limited to special cases.

Conclusions.—The following conclusions may be drawn from these results:

(1) In the oscillations associated with ionization in the form of discharges in dielectrics, especially in cables subjected to high alternating potentials, a clue has been discovered which makes possible the detection of early stages of deterioration.

(2) The various methods developed for measuring these oscillations have laid the foundation for the study of composite dielectrics from a new point of view, namely, that of correlating the processes which take place in dielectrics with the frequencies, amplitudes, and wave form of these oscillations.

(3) With the embodiment of these methods into apparatus new tools have been added to the equipment of research and testing laboratories. These apparatus may serve to control the processes of manufacturing condensers and cables, to safeguard their operation, and to assist in systematic work towards improvements.

A BALANCED BRIDGE FOR TESTING INSULATION*

BY

HUGH A. BROWN

University of Illinois, Urbana, Illinois

In the course of an investigation of the methods of testing high voltage cables apparatus for directly detecting the presence of ionization, discharges in the gaseous voids in the cable insulation under potential stress were evolved. The apparatus and method is readily adaptable to the testing of various types of dielectrics. To make the minute discharge detectable the 60-cycle cable charging current was balanced out with a special capacitance bridge. This bridge is composed of the cable under test, a discharge free zero loss air condenser and two resistance and inductance ratio arms. Variable resistance and inductance is placed in each ratio arm. The junction between the ratio arms was grounded, and the opposite junction (between cable and condenser) was connected to one high voltage testing transformer secondary winding terminal. The other terminal of this winding was grounded. This bridge is adjusted for an amplitude balance of the 60-cycle charging current of the insulation sample and air condenser. Phase balance need not be obtained. When the bridge is thus balanced the presence of the ionization discharges in the cable or other insulation sample can be detected by the characteristic sound in a telephone receiver connected to the output diagonals of the bridge through the medium of a bridge output transformer and a suitable vacuum tube amplifier. A preliminary amplifier followed by an effective inductively coupled filter is provided between the bridge output transformer and the final amplifier, to suppress the unbalanced 60-cycle residue and its harmonics. This makes the ionization discharge more readily

* Published in full in University of Illinois Engineering Experiment Station, Bulls. 259 and 260, 1933.

detectable, and with an output meter connected to the second or final high gain amplifier the comparative intensity of the discharges may be determined.

A known 5,000-cycle voltage is used to calibrate the entire apparatus. The coupled filter is designed to pass a band of frequencies of from 4,000 to 10,000 cycles. The conglomerate discharge frequencies lie within this band. When using a properly designed coupled circuit filter system between stages of the amplifier, the discharge free air condenser may often be dispensed with, so that the amplifier magnifies the ionization discharges. Disturbances caused by the ionization discharges are produced in the variable inductance in circuit with the cable, and these pass through the filter to be amplified. When the apparatus is used in this manner it is found that there is an optimum adjustment of the variable inductance in circuit with the cable for the greatest deflection of the output meter. Thus a complete or partial resonance effect of the circuit to the conglomerate discharge group frequencies of 4,000 to 10,000 cycles is indicated. The apparatus described may be used to test the variation of ionization discharge intensity in a cable with variations of cable voltage, time, cable temperature, etc. Peculiar behavior of the ionization discharges has been noted when such tests are made. Oil filled cable was found to be free from discharges, and the apparatus showed discharges to exist when a small amount of air was pumped into the oil filled cable through a hole in its sheath. If the output meter is replaced by a telephone receiver the presence of the discharge is recognized by a cracking or frying noise. In case of very minute discharges a fine sizzle or hissing sound is obtained. The sound characteristics of various kinds of discharges make an interesting study. The apparatus may be used to detect and measure the ionization discharges in other types of insulation, and it may be used to detect the presence of corona discharges at voltages considerably below those required to produce visible corona.

COMPARATIVE STUDY OF THE EFFECT OF DISCHARGES IN CABLES *

BY

ELLERY B. PAINE

University of Illinois, Urbana, Illinois

SUMMARY

Many peculiar and interesting characteristics of the detectable and measureable ionization discharge currents in paper-insulated cables were discovered. Among the more important is the fact that the insulation is a complex dielectric including solid, liquid, and gaseous materials, in which crystal and amorphous structures may change from time to time with changes in potential gradients, temperatures, chemical products of corona discharge, etc. Ionization discharge starts at a certain voltage impressed upon the cable and increases with the voltage, at first rapidly, then at a decreasing rate. In practically all cables the ionization discharge intensity, as directly measured with a bridge, will occur at voltages below those at which any change in power factor is noticeable. In many cases power factor remained constant, or decreased slightly with increasing voltage, but the ionization discharge intensity, although of low value, increased in proportion to the applied voltage raised to a power greater than unity.

* Published in full in University of Illinois Engineering Experiment Station Bull. 260, 1933.

Comparative studies and results indicate that the falling off characteristic of the ionization discharge with time is due to ionization discharges which are fixed locally in certain gaseous voids in the cable insulation. The cumulative rise of discharge current for the first minute is a phenomenon that has had no parallel which would suggest an explanation. When the ionization discharges do not fall off during the first 30 minutes it is believed that the discharges in the gaseous voids or spaces migrate or shift in their locality. Oil is drawn into electric fields, but special experiments showed that ionization discharges disrupt and scatter oil films in the vicinity of the discharges. Distribution of cable oil or compound is thus effected. This conclusion was arrived at by studies of thin transparent films of mixtures of saturant and air in which electric fields and ionization discharges were active. The increase in power factor did not follow the increase and decrease in ionization discharge immediately. The change in power factor may be due to an end result of previous time-ionization phenomena.

Practically all solid cables showed a certain amount of ionization discharge upon cooling from an elevated temperature down to some critical temperature above the normal ambient value. When a cable is in the process of deterioration, or when a local hot spot is present, the ionization discharge intensity at this particular interval of the cooling may reach intense values.

The impregnation of the paper and interlayer spaces often improves with use, due to redistribution of the saturant, infiltration of oil from joints, terminal potheads, etc.

Oil-filled cables were found to contain no ionization discharges either at operating temperatures or ambient temperatures.

New cables which have recently been manufactured, and have not been in use, nor out of the lead presses in the factory for more than one or two weeks often give ionization discharges which are greater in intensity than those occurring with these same cables, or like cables, when they have been allowed to stand or have been put into actual use. They show formation of voids upon cooling. These characteristic ionization discharges in new cables may in some cases result in slight damage to certain parts of the surface of the insulated paper before they shift or disappear, due to better distribution of the saturant. Although the power factor remained constant for varying voltage, the ionization discharge intensity increased with voltage.

Insulated wires may show considerable ionization discharge within the porous structure of the insulating material, particularly in the case of weather-proof wires, and also in the case of rubber-covered wire, to a certain extent, when the rubber has aged considerably. The existence of the ionization discharges in these pores evidently increases the potential gradient in the solid dielectric portions of the insulation in rubber insulation which has aged to a considerable extent.

Ionization discharges of considerable proportions will exist between the surface of wire insulation and a flat metal contact plate at potential gradients considerably below the value necessary for visible corona discharge, and investigation indicates that this invisible corona has a small but definite deteriorating effect upon the rubber insulation at the line of contact. The physical effect may be that of corona cutting on a small scale.

PHYSICS BOOKS OF HISTORICAL INTEREST IN THE COLLEGES OF ILLINOIS

BY

CLARENCE R. SMITH

Aurora College, Aurora, Illinois

The writer of this paper has been prompted to his theme by two experiences which came to his attention and by an experience of his own, all having to do with the resources of small college libraries in the line of old books. The personal experience was to find in the dead storage of the library of the college of his own employ, an old leather bound volume bearing on its back the simple title, "Newton's Chronolog." This book was stacked among other old theological books, and had been overlooked by many persons of theological interests who apparently did not stop to think that the writer of this volume might have been of far greater fame in other fields. Persons of scientific bent who had passed by this simple title probably did not consider that a writer of a book on theological matters could actually be the great "Sir Isaac" himself. The book was published in Dublin in 1728. How it came into our possession is a mystery except that it doubtless was in some one or other of the numerous private collections which have been presented to the college throughout the years of its history. The book is now in careful keeping and not classified among our resources in theology but a prized possession of our department of physics.

The ordinary college seems to be in a position almost unique for the collection of old books. The heirlooms from many a book lover fall into the hands of descendants who have other tastes. What more kindly disposition could be made of the books than to give them to the college which has already advertised the limitations of its library and its needs for help?

It seemed to be a worth while experiment to choose a field—in this case physics—and tabulate the resources of the various colleges of Illinois as to books of historical interest. The three larger universities of the State were not included since their resources would naturally be large and it was expected that they might obscure the main purpose of the project; namely, to organize resources not commonly recognized. To all the other institutions giving college degrees, a letter was written explaining the project and requesting them to send lists of their books in physics published previous to 1883 and written in English.

The list finally compiled includes 121 titles and represents the replies of sixteen colleges. Among the colleges which failed to respond, the larger institutions were most numerous, probably due to the larger amount of labor required to examine their more extensive collections. It is hoped that this report may serve to stimulate interest that will later lead to more extensive organization of this kind not only in physics but in other fields.

NOTE.—Mimeographed copies of the book list may be obtained gratis from the author.

PAPERS IN PSYCHOLOGY AND EDUCATION

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

The program of the Section in Psychology and Education consisted of four papers, all of which are here represented.

The acting chairman was reelected for the year 1933-34.

(Signed) RALPH W. PRINGLE, *Chairman*

THE QUALITY OF EXTENSION WORK

BY

CLEM O. THOMPSON

University of Chicago, Chicago, Illinois

ABSTRACT

Many criticisms have been made of the extension programs carried on by institutions of higher learning on the grounds that the quality of the work done by students in extension is beneath the level of academic respectability. Work done off campus in some instances may be of a questionable character, but there is no valid argument to support the conclusion that the extension method of instruction is fundamentally unsound when applied to certain subjects. Existing evidence indicates that this method of instruction, applied to non-laboratory courses, is equal if not superior to the classroom method. Supplementing the existing literature on this problem is a recent study made by the writer.

The data show clearly that students receive higher grades when studying by correspondence than when working on the campus. When the factors, instructors and courses, were constant, the difference in favor of students studying by correspondence is over one-half letter grade, and when the factors, students and departments, were constant the difference was over two-fifths of a letter grade in favor of work done by correspondence.

The quality of work done in extension classes is about the same as of that done on the campus. Here, when the factors, instructors and courses, are held constant the difference is two-tenths of a grade point in favor of studying in extension classes; when the factors, students and departments, are held constant, the difference, only one one-hundredth of a grade point, is in favor of work done on the campus.

The significance of these findings is pertinent to the training of teachers-in-service. All of us are aware that there are many teachers now at work who hold life certificates who, because of economic conditions, cannot attend formal classes. But by the extension method of study these teachers can be led to keep up to date. The extension method should also appeal to those who cannot afford to continue their studies toward the completion of a curriculum. May we arrive at the point where we measure an education for what it is worth, not by the geographical location of the student while at work.

THE UNMEASURED VALUES IN EDUCATION

BY

GEORGE D. WHAM

Southern Illinois Teachers College, Carbondale, Illinois

ABSTRACT

Notwithstanding the acknowledged benefits of the use of standardized objective tests, a teacher may be permitted to doubt their present adequacy to measure the ultimate outcomes of education, and to raise the question of whether as commonly used they may not be producing an unwarranted over-emphasis of such outcomes as can be objectively measured, and conversely a wholly unwarranted under-emphasis, if not neglect, of certain tremendously significant values that cannot as yet be objectively and quantitatively measured. If teachers are judged wholly by objective results, naturally they will teach to secure outcomes that can be objectively tested; and just as naturally will they tend to lose sight of the imponderable and at present unmeasurable outcomes, however significant they may be.

Three great educational values are in constant need of emphasis: the *intellectual*, involving not only organized conceptual knowledge but also the cultivation of thought power in its use; the *ethical*, involving goodness and the cultivation of a sensitive concern for the welfare of all; and the *aesthetic*, involving beauty with its soul-stirring sublimation and glorification of the experiences that make up life. These three values I conceive to constitute the very essence of a civilized personality, the very outcomes essential to the operation of a successful democracy.

As previously affirmed, no one of these values has gone a great way toward adequate realization. Much less is there any objective or quantitative test now in existence that can enable a teacher to do more than conjecture how much capacity a given pupil may have in the future in any one of them. As to *thought power*, there is no way of telling how much ability a given pupil may have in future years to assemble his resources of knowledge and through sustained thinking arrive at a solution of some great and intriguing life problem. As to *ethical behavior*, there is no way of telling how much capacity a given pupil may have in the complex cross-currents of his future life to inhibit the selfish and shortsighted desire when promised the kingdoms of the world. As to *aesthetic appreciation*, there is no way of telling how much responsiveness a given pupil may prove to have to the massed glory of light and shade and color of a great picture, or which of two pupils will slump in his seat and which ascend to the seventh heaven in response to the tremendous tone pattern of stimulation of a symphony orchestra.

I may in closing be allowed to express again my misgivings that the success with which the outcomes of some of the techniques and the verbal formulations may be objectively measured may be contributing a sad by-product of neglect of these finer and far greater values that cannot be so measured. As some evidence that I am not wholly eccentric and unsupported in the position I have taken, I close by quoting a typical opinion of a thoughtful educator, Dr. Ambrose L. Suhrie, of New York University:

"The very gratifying progress we have made during the past decade or two in measuring native capacity and the more or less tangible aspects of achievement has unfortunately been accompanied by a deplorable neglect of many of those intangible aspects of spiritual growth which are as yet unmeasurable. We are sometimes almost forced to the conclusion that to do a little good we have quite unintentionally done a great deal of harm."

RELATIVE EFFECTIVENESS OF DIFFERENT REVIEW INTERVALS

BY

H. A. PETERSON, MARY C. ELLIS, NORINE TOOHILL, AND PEARL KLOESS

Illinois State Normal University, Normal, Illinois

Very little of an experimental nature has been published on the question of when one should review. Lyon's work included no experiments on this question.[1] Our own are but a beginning.

(1) *Comparison of a two-day with a seven-day interval.* Here we compared the effects of a review placed two or three days after learning with one seven days after learning, the tests having been given on the 10th and 21st days after learning. The subjects were freshmen in elementary psychology at the Illinois State Normal University. The equivalent group method was used, there being three groups of 14 each in the first trial, and 21 in each of three groups in the second trial. Two trials were made to increase reliability. One of these groups reviewed two or three days after learning, the second, seven days after learning, and the third had no review. The materials were 6-page passages of historical and psychological reading matter of suitable difficulty. The directions were to study them in the manner customary in social science classes. The study time was 50 per cent more than the reading time of the selection. At the close of the study time a question-and-essay-answer test was given. The reviews were duplicates of the original learning conditions, except that there was no test. Ten and 21 days after learning all of the groups were tested, using the same test as on the previous occasion.

Results. In general there was a slight advantage for the shorter interval, but the difference was not great enough to be significant. We think that what happened was that the advantage of an early review before much fading out had occurred was about compensated for by the advantage of a review near testing time.

(2) *Comparison of a one-day and a nine-day interval.* Here each advantage was increased in intensity. The result was the same as before; the reviews after these intervals were approximately equally effective. In this experiment the subjects were sophomores, and the materials were of the ordinary sociological reading matter variety. One of them was 11 pages long and rather difficult.

Conclusion. While of course memory fades in the manner depicted by the usual curves of forgetting, the situation is complicated by the relation of the reviews to both learning and the times of reproduction. A review that occurs soon after learning rescues more from oblivion than one that comes later, but it is also longer in advance of the time when the information will be used than is the later review. In the cases tested above these advantages appear to be about equal in strength.

[1] Lyon, D. O., The Optimal Distribution of Time: Jour. of Ed. Psych., 1914.

A PSYCHOLOGICAL VIEW OF THE DEPRESSION

BY

J. A. MELROSE

James Millikin University, Decatur, Illinois

The depression is called an economic depression because its acute symptoms are economic. The name is inadequate. We have economic plenty but bad distribution and the basis of the latter is inadequate social and moral thinking.

Human culture started with original nature and its needs. That nature and those needs are basicly unchanging. The latest baby born presents to our complex culture essentially the same nature that babies presented to incipient culture before the dawn of history. Culture is never "passed on"; it is created anew in each generation upon the original nature and needs of babies and growing youth. Original human nature started all culture and continues to be the basis of all sound cultural norms.

Man has a dual nature of *'feeling'* and *'sensation'* which function over definite and distinct mechanisms in his body. These basic factors of his nature and intelligence are the foundations respectively of his *'spiritual'* and *'physical'* experience and become generalized socially under the respective terms of *culture* and *civilization*. Feeling is the deeper element; it lodges close to the life of the self and responds to the sensory or physical world with accepting or rejecting reactions. It is the center of values and choice, viewed in common sense terms.

A well ordered culture must keep *'feeling'* and *'sensory'* factors in the same general relation to each other that they have by nature in the functioning of the human individual. Progress does not consist in a mere increase of material resources. It is a dual process depending upon the intrinsic duality of human nature and need. Social progress involves both a material advance and a progressive readjustment of this advance to human and social needs. When this latter adjustment lags a "moral deviation" occurs which threatens the stability of the whole culture.

The principle of coordination between the *'physical'* and the *'spiritual'* factors of human nature and human culture has the widest generality of all social principles. Religion (when not exploited) has addressed itself in all ages to the task of maintaining this basic cultural equilibrium. This is why all primitive religions consider their religion their "prosperity policy."

The Middle Ages overstressed *feeling* and built culture too much around it. They neglected *sensory* knowledge. Modern times reacted from this extreme and in time swung to the other extreme. There has been overweening interest in material progress to the neglect of values. This movement has in turn run its course and as there has been no adequate guidance back to cultural balance there has been going on a blind retreat back to feelings to be noted in individualism in thought, religion, and morals, and a lapse from the *head* to the *viscera* in expressionism in art, the cult of unintelligibility in literature, Emperor Jones in opera, and jazz in music. Material superstructure cannot continue to rise while cultural foundations weaken and give way.

PAPERS IN ZOOLOGY

EXTRACT FROM THE REPORT OF THE SECTION CHAIRMAN

The Zoology Section, after the first five papers on the program, divided into two groups to hear separate programs of eight papers in Zoology and seven in Entomology.

Articles not here represented are as follows:

"Morphological and Life History Studies on *Stylet cercariae*," by D. B. McMullen, Monmouth College, Monmouth, Illinois.

"Temperature Effects on the Heart Rate of Double Embryos of Fundulus," by Marie A. Hinrichs, Chicago (read by title).

"Some Studies on Guppyi, (*Lebistes reticulatus*)," by Vernice Rathwell Wodrich, Bradford, Pennsylvania (read by title).

"The Pretarsus (Articularis) in Coleoptera," by W. P. Hayes and C. W. Kearns, University of Illinois.

Average attendance at the meeting was thirty, maximum was forty-two.

It was voted to leave the selection of the chairman for 1933-34 to the Council.

(Signed) WILLIAM P. HAYES, *Chairman*

A CONCEPT OF SPECIES AMONG FISHES

BY

DAVID H. THOMPSON

Illinois Natural History Survey, Urbana, Illinois

AN ABSTRACT OF ORIGINAL OBSERVATIONS

Counts of the numbers of spines and rays in the fins of darters show that the degree of difference between the mean spine or ray counts of two populations increases as the water distance between these populations increases. It has not been possible to relate these differences in mean spine or ray numbers to differences in the environment.

During the past two years counts have been made of the spines and rays in the fins of many other kinds of Illinois fishes. By using the mean number of spines or rays in each of the seven fins of each of the spiny-rayed fishes of the state (a group comprising 47 species), we have been able to calculate coefficients of difference (the average of seven percentage differences) between any two species. These coefficients of difference for all combinations have been summarized in a table. From this table it is possible to construct a family tree showing the degrees of relationship of these 47 species, as well as their relative rates of evolution. This biometrical family tree of spiny-rayed fishes corresponds very closely to those family trees constructed by systematic ichthyologists from a much wider range of characteristics and is less open to criticism since it involves the experience and judgment of the investigator to a smaller degree.

Sterile hybrids are found in nature which involve six kinds of Illinois sunfishes. The occurrence of hybrids between certain described species and genera of sunfishes and not between others offers the possibility of an empirical test of the validity of coefficients of difference as indices of degree of relationship. The parents of 14 known hybrid combinations all show coefficients of difference below 4.7 per cent. Furthermore, combinations of these six species which are known to enter into sterile hybrids are the only ones which show coefficients of difference smaller than 4.7 per cent. Other nearly related species among which we are fairly certain hybrids do not occur show coefficients exceeding 5.7 per cent. For example, the two species of crappies, which from external appearances and general morphological characteristics resemble each other more closely than do many of the species which are known to hybridize, show a coefficient of difference of 5.7 per cent. Similarly, the large mouth black bass and the small mouth black bass resemble each other closely but show a coefficient of difference of 6.1 per cent.

The genetic meaning of this relation between hybridization and differences in the spine and ray counts of the fins is not clear. The most promising viewpoint seems to be that the *number* of spines or rays in a fin has little adaptive significance and that changes in the general genetic constitution produce random plus and minus variations in this number. Averaging the percentage differences of seven fins expresses the total amount of genetic difference between two species more accurately than does the difference in one fin.

BIOLOGY IN HUMAN BEHAVIOR

BY

C. E. MONTGOMERY

DeKalb, Illinois

Although biology in one aspect or another has been a part of public education for nearly a half century, its real application to human life does not mean much to the average person of today. Except to those who have done special work in some field of biology, the year of required work in many of the higher schools means little more than another subject to fill up the curriculum. The lack of ability of the ordinary individual to see the importance of biology in its many applications to daily life should be the greatest concern of the teacher of this subject. This work should not be offered as a panacea for all human ills but to create a deeper understanding in the lay mind of the fundamental life processes. The fact that man is a member of the great living organization should place the subject of biology in the schools on the same plane as the conventional three R's.

Upon examination of the biological courses offered by the colleges and universities one need not be surprised to find the situation as it is. The old standard courses of botany and zoology are excellent for the specialist in these lines but they offer little useful material to the person who never does further serious work in biology. A large percentage of college graduates have had the regular year of work in some biology course, yet when faced with common community problems that involve biological knowledge they are no more able to aid the situation than those who have not been in college.

The forces of heredity and environment have so fashioned the human being that no clear understanding of the life of man is possible without a knowledge of both of these in their various relationships. One should know not only something of how heredity works but the nature of the living materials which are inherited and what environment does to develop it. Truly the biologist does not know all the facts about life, yet if the known facts should be impressed on the mind of the average layman, many problems of life would be much more easily solved. Crime, pauperism, health, recreation, sanitation, etc., are not merely social in character but are fundamentally biological.

The social worker, minister, teacher, judge of our courts and all others who are trying to alleviate human difficulties must of necessity know the nature of the chemical machine with which they are dealing. The failure of the human family to improve itself along with the development of its civilization is due largely to the lack of real information concerning its own animal nature.

The suggestions of this paper are offered to biology teachers with the hope that they may stimulate further consideration of the problem of bringing more practical phases of biology to the general student.

FAMILY ORIGINS IN A SOUTHERN ILLINOIS COMMUNITY

BY

CLARENCE BONNELL

Harrisburg Township High School, Harrisburg, Illinois

This is a study of family histories of 140 biology students in the Harrisburg Township High School in connection with similar studies over a period of years, made originally in relation to problems in heredity.

Harrisburg township is a typical Ohio River Valley community of 15,000 people situated twenty miles from the river. It has two main industries, farming and coal mining, upon which other industries depend. Many miners own their homes. Their children constitute a large part of the school and are among the best students.

Thirty years ago the population was stabilized. Almost any family name in the township could be found in some other similar Ohio River Valley community. Their ancestors had come largely by way of the Cumberland Gap or down the Ohio in the days of flat boats. Fully half of the students in 1933 had ancestry traceable to Kentucky, Tennessee, Virginia, Georgia, and the Carolinas. A later migration of Germans and Irish was also fused with the earlier comers. Strangely, not less than ten per cent of this stabilized population had some American Indian blood traceable to such tribes as the Pawnees, Cherokees, and Crows.

Development of the immense coal fields following 1900 brought many families from the Ozark Hills region in adjoining counties and from southern Indiana and Kentucky. These differed little in origins from those who had come in the century before. Soon a new element came, mostly Lithuanians and Hungarians. To this was added a few English and Scotch miners and a scattering of other Europeans. (The negro population is omitted in this discussion.) Thus, the population increased five-fold in thirty years.

The older English-Scotch-Irish-German-French-Dutch-Welch stock, which came during the nineteenth century and became amalgamated in the Ohio Valley, refer to the newer Europeans as "foreigners". This older group and their descendants have traditions retained from the days of trappers, Indian fighters, and Black Hawk, Mexican and Civil War veterans. The ancestral elements of this group are now so blended that they are discovered only by tracing the line of descent. The surnames no longer indicate national origins. All these groups, the older ones which came during the century after the Revolutionary War and the Europeans who came during the first twenty-five years of the present century, are now so well assimilated that their children in the high school of 1000 students are not distinguishable by speech, scholarship, manners, dress, physical appearance, or traditions. Outward appearances are gone although a foreign language is spoken in some of the homes and some of the children can speak one or more of them. Two more generations will see the family trees branching to include representatives of all these groups in nearly every family. With immigration limited and transportation and communication increased, and through the influence of schools, there will be nothing remaining in this community to distinguish national origins except as they may be traced in family histories.

ALBERTUS MAGNUS, THIRTEENTH CENTURY ZOOLOGIST

BY

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Albert Graf von Boldstädt, son of the nobleman, Count von Boldstädt, was born in Lauingen, Suabia in 1193. In his early youth he left his native home to attend school in Padua. There he entered the Dominican Order in 1223. After the completion of his studies he was given the work of teaching and of organizing schools. He taught at Hildesheim, Freiburg, Strasburg, Ratisbon, Paris and Cologne. At Paris he received the bachelor's degree and the licentiate. At Paris, too, he received the doctor's cap about the year 1245. His almost continuous program of study, teaching and writing was at least partially interrupted several times by the imposition of difficult offices of trust and dignity including the office of provincial of the Dominican Order in Germany, 1254-57, and the bishopric of Ratisbon between the years 1260 and 1262.

Of Albert's voluminous writing, *Opera Omnia*, including theology, philosophy and the natural sciences, two complete editions have been published, one at Lyons in 1651 in twenty-two folio volumes, and the other in Paris in thirty-eight quarto volumes in 1890-1899. The part of his works which treat of plants and animals is contained in the treatise on nature (Opus naturarum) and includes *De Plantis* and *De Animalibus*.

De animalibus is divided into twenty-six books; the first nineteen of these are based upon Aristotle's works on animals; the next two books deal with Albert's own observation on the form and structure of animal bodies, the perfections and imperfections of these forms and their causes. Books twenty-two to twenty-six inclusive contain the descriptions of a large number of animals many of which were described by Albert for the first time. The animals described include 113 quadrupeds, 114 birds, 130 aquatic animals, 61 reptiles and reptile-like animals, 41 worms and worm-like animals.

At the suggestion of Richard von Hertwig, Dr. Herman Stadler delivered a lecture entitled "Albert the Great as an independent student" before the Verein fur Naturkunde in Munich on March 20, 1905. Stadler published in 1916 and 1920 a complete edition of Albert's *De Animalibus* from the original Cologne manuscript. This splendid and elaborately indexed edition, dedicated to Richard von Hertwig and Erich Wasmann, S. J., appears as volumes 15 and 16 of the *Beiträge sur Geschichte des Philosophie des Mittelalters* and covers over 1700 pages.

Prof. Heinrich Balss, Haupt Conservator of the zoological collection of the University of Munich, published a monograph through the Munich press (1928) entitled *Albertus Magnus als Zoologe*. In this exposition of 115 pages there are nearly one hundred titles included in the bibliography and literature citations.

When one stops to consider that zoology was but one of practically all of the natural sciences among which Albertus Magnus divided his energies; and that perhaps an even greater amount was devoted to philosophy, theology, teaching and the many other responsibilities and occupations that crowded into and filled his life, there seems to be no other conclusion than that of George Sarton's that Albert's activity was nothing short of miraculous. (Introduction to the history of science, vol. 2, p. 933.)

Albertus, who because of his remarkable versatility won the two significant titles of "The Great" and "Doctor Universalis", was canonized nearly seven centuries since, Sanctus et Doctor Ecclesiae by the present reigning pontiff, Pope Pius XI, on December 16, 1931.

THE MOLLUSCAN FAUNA OF THE GREAT RIVER VALLEYS OF ILLINOIS

BY

FRANK C. BAKER

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The paper lists the Molluscan land species found in ten localities on the Ohio and Mississippi river banks from Hardin County on the Ohio northward to Jo Daviess County on the Mississippi. It shows that the number of species increases southward, certain species being found only in southern Illinois while others are restricted to the northern part of the State. The river bluffs are peculiarly adapted to the needs of land snails; they afford protection and food as well as moisture, and the numerous outcrops of limestone afford lime in abundance. Several races are confined to the large valleys. Two species, known only from the Mississippi River bluffs in the southern part of the State, are believed to be migrants from Missouri.

The paper is based on field work carried on for the State Natural History Survey during 1931–1932 for the purpose of obtaining data needed for the preparation of a handbook of the land mollusks of Illinois.

A SYNONYMIC CATALOG OF THE REPTILES AND AMPHIBIANS OF ILLINOIS

BY

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ABSTRACT

The object of the paper was to present a complete bibliography of Illinois herpetology, with a concordance of the scientific names used, in the hope that a greater interest in our herpetofauna might be awakened and encouraged. Since there is at present insufficient Illinois material in museums to warrant a really comprehensive work on the reptiles and amphibians of this State, and since the only inclusive account was published over forty years ago, such a listing serves to bring the subject up-to-date for further research.

Sixty papers dealing with Illinois herpetology enumerate seventeen species of salamanders, nineteen of frogs, five of lizards, forty-one of snakes, and fourteen of turtles actually found. *Natrix sipedon confluens* Blanchard, not previously reported from the State, is added on the basis of specimens from Olive Branch, Alexander County, in Field Museum of Natural History.

The author urgently requests all persons interested in this part of our fauna to communicate with him and to cooperate in his work toward a "Herpetology of Illinois."

A STUDY OF THE PHARYNGEAL TEETH IN THE BLUNT NOSED MINNOW

BY

RAY CHAMBERS

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The taxonomic value of the teeth of fishes is readily expressed in the following quotation from D. S. Jordan, 1910. "No progress can be made in the study of these fishes (Cyprinidae) without careful attention to the teeth, as the genera are largely based upon dental characters." Cox, 1897 says, "It is often necessary to know the nature of the lower pharyngeal bones and teeth in identification, especially in suckers, minnows, and sunfish." Inasmuch as these characters have been stressed as taxonomic guides it is necessary to establish them as unvarying in order to give them their full value.

This account, a summary of the results obtained from a study of 56 specimens of the blunt-nosed minnow, shows that there are deviations in numbers and arrangement of the teeth in individual specimens as well as for different specimens of the group.

The pharyngeal teeth are situated on the pharyngeal bones of the fifth brachial arch. They are used as masticatory organs and possibly aid in affording the fish a chance to taste his food. The teeth are composed of the three tooth tissues. The prismatic structure of the enamel is not well marked and is probably absent in some cases. The cement is more appropriately named "bone attachment."

Fifty-six specimens were examined and it was found that 41 had the normal dentition formula of 4-4 as given by various authorities. The remaining 15 showed various deviations from the normal involving asymmetry between the two sides in the same fish as well as the presence of both supernumerary and subnormal numbers of teeth.

The size of the individual seemingly does not have any direct relationship to the number and arrangement of the teeth. This is shown by the fact that of a group of five specimens 48 mm. in length three had the normal dentition formula of 4-4, one of 4-4,1 and another of 2,4-4,2.

In some of the bony fishes teeth are "shed" but the old tooth functions until the new one is fully developed and ready for use. In one specimen there were four teeth on one side and three on the opposite side but there was not the slightest indication of regeneration of the "missing" tooth.

The main row of pharyngeal teeth is fastened directly and firmly to the pharyngeal bones. The median teeth are usually very broad and rather heavy with a sharp hook. Adjacent teeth laterad of the meseal series become longer, more slender, and more sharply hooked.

The secondary teeth are in a longitudinal row immediately posterior to the main row. They are arranged so as to fit between two teeth in the primary row and are fastened to the jaw by means of strong ligaments. The median secondary tooth is almost as heavy as the median primary one. It is broader and shorter with about the same angle of hook. It is less than one-third the length of the adjacent primary ones.

CONCLUSIONS

(1) The pharyngeal teeth furnish important data for identification of fishes but in the blunt nosed minnow neither the number nor the arrangement is absolute.

(2) The pharyngeal teeth are variable in form within the species or even in the same individual.

(3) In the blunt nosed minnow the size of the specimen has little or nothing to do with the number of pharyngeal teeth.

(4) The secondary row of pharyngeal teeth is not firmly attached to the pharyngeal bone.

SHELL INJURIES OF LAND MOLLUSKS

BY

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ABSTRACT

F. C. Baker and others have called attention to the importance of the study of abnormal specimens of Mollusca in papers discussing monstrosities found in the Unios, with reference to variation and possible specific change. One type of abnormality which has no relation to the problem of evolution and yet has considerable biological importance is that sort of abnormality associated with or resulting from damage to the shell or to the animal. Under conditions of nature molluscs are constantly subjected to injury of the shell either by attack of predators or by accidental breakage. Studies of repair and abnormality due to injury to the mantle seem to be lacking in the recent literature.

For two years, monthly collections of land snails have been made in the vicinity of White Heath, Illinois, on the floodplain of Sangamon River. This habitat appears to be optimum for the development of *Polygyra thyroides* and *Polygyra pennsylvanica* because of their abundance. In making the October collection, a living specimen of *P. thyroides* was observed to be seriously injured, bearing a large irregular hole in its shell. This hole was so large that the foot extruded through it instead of through the normal aperture when the snail crawled. The specimen was brought to the laboratory and kept under observation. In 26 days the repair was completed and the individual was apparently normal except no cuticle was formed over the regenerated portion of the shell. The study of this individual suggested a statistical study of the adult shells in the combined monthly collections for evidence of mishap.

Of the 401 specimens of *P. thyroides* examined, 133 had recorded on their shells some form of injury. About 33 per cent of the adults were injured in some manner. Most of the injuries were of a minor character although about 5 per cent of the total number had injuries that involved serious damage to the shell. Sixty-six specimens of *P. pennsylvanica*, taken from the same habitat, exhibited about 15 per cent of the total injured of which again 5 per cent bore major injuries.

Injuries of like nature were observed to occur in other species found associated with these two species. No attempt is made to explain the cause of these injuries. The habitat is an undisturbed woodland on a river floodplain, free from domestic animals, so the snail injuries cannot be the result of their tramping. No doubt the amount of injury is closely correlated with the specific habits. Active species exhibit more injuries than the more seclusive forms.

These observations have particular value in demonstrating the extent to which repair is possible for the injured shells of land snails. The region of the aperture and especially the reflected lip seem to be particularly susceptible to accidental breakage but here the free edge of the mantle which secretes the shell facilitates reconstruction. Regeneration of broken areas far removed from the aperture gives evidence that the mantle surface is capable of reforming new shell material. In many cases traumistic injuries inflicted damage to the mantle and other soft parts of the body as demonstrated by abnormal form of the shell of the injured snail. In numerous specimens injuries to the mantle became perpetuated as spiral incised lines or ridges continuing in successive whorls as the shell grew in size beyond the damaged area.

A COMPARATIVE STUDY OF RIVER POOL AND POND COMMUNITIES, WITH SPECIAL REFERENCE TO THE SPHAERIIDS

BY

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In connection with life history studies on the finger nail shell, *Sphaerium solidulum*, carried on at the University of Illinois under the direction of Dr. H. J. Van Cleave, observations were made concerning the habitat relations of this species.

Collections were taken from an oxbow pond near Muncie, Illinois. This pond formed part of the stream bed of Stony Creek until the stream was straightened during the building of a railroad grade in 1872. Part of the pond was deepened by removal of soil for the railroad grade. Since then the portion of the old stream-bed connecting the pond with the stream has been filled by sedimentation and the encroachment of vegetation. This area now supports cat-tail, willow, and button-bush. Elodea and algae grow in the pond near the shore.

The sphaeriids are numerically predominant in the pond community. A bottom sample from 1/16 sq. m. of bottom yielded 120 *Sphaerium*, 3 *Physa*, and 1 leech. Other animals taken at different times were: snails, *Helisoma* sp.; other sphaeriids, *Musculium* sp., and *Pisidium* sp.; mussels, *Uniomerus tetralasmus;* backswimmers; water beetles, *Petlodytes 12-punctatus;* burrowing dragonfly larvae, *Gomphus* sp.; mosquito larvae; red chironomid larvae; leeches; crayfish, *Cambarus propinquus;* amphipods, *Hyallela knickerbockeri;* isopods, *Asellus communis;* frogs, *Rana pipiens* and *Acris gryllis;* turtles, *Chrysemys* sp.; sunfish, *Lepomis* sp.; minnows, *Notropis* sp.; suckers, *Catastomus* sp.; mud cat, *Amicurus* sp.

Collections from pools connected with the stream in Stony Creek and in Salt Fork into which it flows yielded: crayfish, *Cambarus propinquus;* minnows, *Notropis whipplei, N. gilberti,* and *Hyborhynchus notatus;* suckers, *Catastomus nigricans;* black bass, *Micropterus salmoides;* isopods, *Asellus communis;* burrowing dragonfly larvae, *Gomphus* sp.; red chironomid larvae; mussels, *Lasmigona complanata, Cyclonaias tuberculata,* and *Lampsilis* sp.; water beetles, *Petlodytes 12-punctatus;* snails, *Goniobasis livescens;* sphaeriids, *Sphaerium solidulum* and other species of *Sphaerium;* Bryozoa, *Plumatella* sp.; caddis worms *Hydropsyche* sp.; mayfly larvae, *Hexagenia* sp., and *Heptagenia* sp. Of these the crayfish were numerically predominant. The sphaeriids were not numerous.

Trematode larvae of the family Allocreadiidae develop in the sphaeriids of this locality. The metacercaria encyst in *Hexagenia* nymphs, and the adults are found in fishes (*Lepomis* and *Amicurus*). Thus the entire life history of these trematodes is accomplished within the pool community.

The stream-bed pools represent the earliest stage in a hydrosere leading to dry land. The pond fits into this sere, and the marshy area adjoining the pond represents a stage still more advanced. The pond has a number of species in common with the stream pools. These include *Cambarus propinquus, Sphaerium solidulum, Asellus communis,* the chironomid larvae, and some of the fish. Other species (as *Goniobasis, Hydropsyche,* and *Heptagenia*) taken in the stream pools are typically rapids forms which are only visitors to the pool community. Other stream pool species (as the *Hexagenia* and the mussels) disappear altogether in the pond. The sphaeriids, however, which occupy only a minor place in the stream pool community, become overwhelmingly predominant in the pond.

VARIATIONS AMONG ATYPICAL SPERMATOZOA IN VALVATA TRICARINATA

BY

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ABSTRACT

Among the gastropod molluscs the Prosobranchs present a variety of conditions of sexuality. The Prosobranchs, in fact, are, in a majority of instances gonochoristic, but, other members of the group are generally hermaphroditic. In certain other cases some members pass through phases in which the animals are first gonochoristic, then hermaphroditic, only to become, later on during the life cycle, gonochoristic or unisexual.

It appears significant, especially, in the light of recent investigations in sex differentiation that a series of variations should occur in the process of spermatogenesis in this hermaphrodite snail. In *Valvata tricarinata* the early gonial stages pass through separate strata during the period of sexual segregation, and later, spermatogenesis and ovogenesis occur at the same relative time. Always the male cells mature a short time before the ovocytes. It seems probable that the presence of a tendency toward increasing abnormality in the apyrene group may be the result of the interaction of the male and female systems which are so close together in the hermaphrodite gland.

Altogether three species of Valvata, one American and two European species have been studied to-date and each species has presented a widely differing set of conditions of spermatogenesis. *Valvata piscinalis*, which was first studied by von Kemnitz (1914), occupies a position in many respects similar to the unisexual gastropods. Von Kemnitz has established that only a single typical spermatogenesis occurs in *Valvata piscinalis*. Later, Artom and Cavallini (1931) in a careful study reported on both *Valvata piscinalis* and *Valvata cristata*. Their conclusions tend to confirm the work of von Kemnitz in showing again the total absence of an aberrant spermatogenesis in *Valvata piscinalis* and a definite tendency toward a typical spermatogenesis in *Valvata cristata*.

It is certain from a study of the conditions of sexuality in the three species of *Valvata* mentioned above that a series of increasing tendency toward aberrant spermatogenesis occurs in this genus with *V. piscinalis*, *V. cristata*, and *V. tricarinata* forming a series of increasing tendency toward a typical sperm formation.

INSTINCT BUT A RESPONSE TO THE LAW OF HABIT

BY

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ABSTRACT

"Inherited habit" as applied to instinct is of course not new. I am however just now attempting to not only show that there is such a thing, but also to tell what it is and how it acts. The organism being but the sum total of its cell units is therefore a thing dominated by the cell. But the cell in its turn is also a thing dominated by what has gone before. It is but that which has been moulded and fixed by many repetitions in past generations—a thing dominated by what I would call the "law of habit." In the full article I have especially endeavored to bring out the following points:

(1) By no process of reasoning could instinctive knowledge in the newly born be accepted as a thing which had been imparted by the mother to the offspring through either teaching or example.

(2) When we fully realize that the cell never dies but merely divides or fertilizes itself, passes over to the next generation and there continues to live, then should we also know that acts in the newly born which were a part of the life conduct of the ancestors for many previous generations must be but the automatic repetitions in the new organism of such life conduct of the past.

(3) In setting forth the modus operandi by which this is done, I have sought to show, through a study of the *law of habit* that such repetitions cannot be other than simply that which is compelled by the operation of the uncanny principles of this law. The cell itself, in previous generations, having originally taken on the habit of breeding true through thousands of repetitions and then never dying simply keeps right on repeating in the new organism through the compelling influence of habit the same old practice. Habit having become master the act can not now be done in any other way than by the routine one which is directed by the habit.

(4) As an analogy, attention has been directed to the fact that such things as Leibnitz's law of continuity, Von Baer's law of embryonic development, Galton's law of regression, Mendel's law of heredity, and the fixity of "kind" which is everywhere apparent in nature, may also be all included in the same category. As the planets respond to Keppler's laws of planetary motion so the thing we call instinct, similarly compelled by the *law of habit*, becomes but another one of the great cycles and rhythms of nature. A fool-proof automatic thing in which neither brain nor intelligence is involved and which occurs alike in vegetable as well as in animal life.

(5) Finally, to better explain the thing we call the "homing" instinct, it would seem to be necessary to add to the "special senses" of touch, taste, smell, sight and hearing one or two other similar but yet unknown senses which, if they exist at all in man are today only rudimentary.

AMBYSTOMA TALPOIDEUM (GRAY) IN ILLINOIS

BY

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ABSTRACT

During some explorations in November, 1931 in Southern Illinois, several specimens of the Mole salamander, *Ambystoma talpoideum* were found. The only previous record of this particular salamander's being found in Illinois has been the one made by Kennicott.

This time the collections of *Ambystoma talpoideum* were made on the island at Horseshoe Lake, a State Game Preserve about one mile south of Olive Branch and about fifteen miles north of Cairo. Originally Horseshoe Lake was an old oxbow of the Mississippi River and it is one of the few remaining original Cypress swamps in Illinois.

The particular area where the specimens of *Ambystoma talpoideum* were found was at the base of a sloping hillside which constitutes the shoreline of the island. Usually during seasons of high water this portion is flooded.

When found, *Ambystoma talpoideum* was under rotten logs buried in the ground about an inch or so. It had the characteristic lichen-like markings on its body making it harder to find.

Ambystoma talpoideum seems to be one of the rare species in this locality. Usually it is considered one of the southern salamanders. Finding it not only adds another record for its being in Illinois but also establishes a new northern limit for this southern species.

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NATURAL VS. ACCIDENTAL DEATH IN DIFFERENT HABITATS OF THE SNAIL *VIVIPARUS CONTECTOIDES*

BY

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ABSTRACT

Different habitats for *Viviparus contectoides* have been studied in a detailed investigation of the life cycle (VanCleave and Lederer, 1932). Normally the females of this species have a life span of about three years, while males live but a little more than one year. In the Erie Canal (Durhamville, N. Y.) studies gave evidence that natural death is the chief factor reducing populations except for the young snails consumed as food by other animals. In the Illinois River (above Peoria, Illinois) entire populations of this snail are killed off by toxic effects of sewage. Evidences and interpretations are discussed.

BEYOND THE WALLS OF THE MUD-DAUBERS' NESTS

BY

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ABSTRACT

A study of over 1,000 nests of the yellow mud-dauber, *Sceliphron cementarium* shows that three factors determine the location of nests—protection from rain, light, and enemies. Of these, protection from rain is perhaps the most important. In the matter of construction there appears to be no particular uniformity in the arrangement of their structures. Cells within the same nest may vary in size and shape. Of the number examined, only 41 per cent contained closed cells, 567 contained, besides the host, the prepupae of the blue wasp, *Chalybion caerulium*. Differences in the prepupae of both are described. A total of 233 closed cells were found to be entirely empty, and 523 cells were provisioned with spiders, with an average of four spiders per cell. The spiders used for provisioning the nests are listed, and also the parasitic and predaceous enemies. Among these a chalcid wasp, *Melittobia chalybii*, is the most important parasite.—*Abstracted by Wm. P. Hayes.*

SOME INFLUENCES OF MAN ON BIOTIC COMMUNITIES

BY

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ABSTRACT

The introduction of civilization into a primitive area involves: (1) extinction of the large and slow-multiplying animals; (2) destruction of climax vegetation and much of the animal life which depends upon it; (3) spread of certain plant forms which are man-tolerant, and essentially sub-climax in nature; and (4) modifications of number-relations among the smaller animal species which are man-tolerant. Some of these smaller animals merely adjust their habits so as to survive under the new conditions, usually with reduced numbers (skunks, opossums). Some, however, are actually benefited through an increase of food or of suitable breeding places, or through the destruction of their enemies (some rodents, birds, and insects). These are enabled to increase their numbers and extend their range. At the same time civilization brings with it a very definite biota of parasites and weed forms, both plant and animal, which are able to survive and propogate most successfully under man-influenced conditions.

Thus in areas where civilized man is well-established there are developed biotic communities of civilization which contain the following elements: (1) man, (2) domestic animals and plants, (3) man-tolerant native animals and plants, (4) imported weed forms, plant and animal, (5) parasites, native and imported. These different elements assume different degrees of relative importance according to whether we are studying (1) communities of man's dwelling and its environs; (2) communities of meadows, pastures, and cultivated fields; or (3) communities of relict woodlands and other semi-wild areas.

Conditions over a region may remain essentially primitive even though settled agriculture is practiced over certain portions of it. Such conditions persisted in Western Europe until about 1300 A. D. Up to this time great areas of forest remained uncut, and most of the larger animals were still found in them. During the period from 1300-1700 these forests were largely cut or burned, and the wild life destroyed. This period of biotic disturbance in Europe corresponds to the period from 1650-1880 in America, and from about 1820-1900 in certain parts of Australia. In all three cases the period was marked by destruction of natural conditions and wild life, and also by great increases in human population and extraordinary prevalence of epidemic disease.

Such a period gives way to one in which the destruction of natural conditions is largely completed. At the same time diseases tend to be endemic rather than epidemic. This change in the nature of their occurrence seems to be independent of any medical advance. Somewhat later, but belonging in the same train of events, the human population comes to increase much more slowly or actually reaches a level, and violent changes in the number-relations and range of animal species cease to take place. Thus the biotic community, with those elements eliminated which were not man-tolerant, and with the addition of the new elements which were brought in by civilization, strikes something like a balance.

NOTES ON THE FLIGHT AND ABUNDANCE OF THE SEED CORN BEETLE, *AGONODERUS PALLIPES* FAB.

BY

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The purpose of this paper is to assemble various scattered notes that have accumulated during several years relative to the flight habits of the beetle, which indicate that there are two definite flight periods each year, fall and spring.

Fall flight periods have been noted in the following cases: (1) Morgan county, October 1, 1925; (2) Calhoun county, October 2, 1925; (3) Calhoun county, September 9, 1927; (4) a flight late in September, 1932, which is well recalled, though the date was not definitely noted at the time.

Spring flights were noted as follows: (1) Macon county, April 12, 1923; (2) Pike county, March 25, 1925; (3) Morgan county, March 19, 1926; (4) Morgan county, March 23, 1926; (5) Greene county, March 22, 1928; (6) Sangamon and Christian counties, March 24, 1929; (7) Warren county, April 7, 1931; (8) Morgan county, April 9, 1933.

Specimens have also been noted as follows: (1) Adults under clods in a corn field, Adams county, May 5, 1925; (2) Adults under trash in field of clover, Morgan county, June 25, 1925; (3) Pupae and emerging adults dug from around roots of corn at Carlinville, Macoupin county and Lebanon, St. Clair county, June 26-27, 1930; (4) Pupae dug from roots of corn at Carthage, Hancock county, June 27, 1932 and adults emerged from this material July 5, 1932.

TABLE I

Infestation by the Seed Corn Beetle, Agonoderus pallipes Fab., in Four experiment fields, 1929-1932.

Treatment.	Per cent of infestation.				
	1929	1930	1931	1932	Average
Carthage					
Animal residue series	6.0	0.0	0.0	37.0	10.8
Crop residue series	.5	0.0	1.0	9.0	2.6
Clayton (Early plowed)					
Animal residue series	4.5	6.0	(a)	33.5	14.7
Crop residue series	0.0	2.0	(a)	21.0	7.7
(Late plowed)					
Animal residue series	6.0	5.0	(a)	25.0	12.0
Crop residue series	1.0	1.0	(a)	14.0	5.3
Carlinville					
Animal residue series	0.0	12.0	0.0	2.5	3.6
Crop residue series	0.0	1.5	0.0	2.5	1.0
Lebanon					
Animal residue series	.5	9.0	----	----	4.8
Crop residue series	1.0	2.5	----	----	1.8

(a) No records.

Hibernation as adults is indicated. Data suggest that the period of immature stages is from early May to late June or early July, 6-8 weeks. There is no evidence of a second brood, but it is shown that sufficient time elapses for it to be possible.

For the first time definite data are published showing the relative abundance of this insect under two rotation practices. Studies were carried on at experiment fields of Illinois Agricultural Experiment Station.[1] Table I gives records for two rotations, (1) Animal residue for fertilizer, four year rotation where manure precedes corn planting; (2) crop residue, four year rotation where sweet clover is plowed under as green manure crop preceding corn.

It appears that the adults choose an area where there is an abundance of decaying manure in which to feed and deposit their eggs. Feeding habits are not definitely determined. Time of plowing is not indicated as important.

[1] Cooperation of Dr. F. C. Bauer, in charge, Soils experiment fields, Illinois Agricultural Experiment Station.

CODLING MOTH HIBERNATION IN BANDED TREES *

BY

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ABSTRACT

This paper is an attempt to answer the questions propounded by apple growers regarding the percentage of larvae of the Codling Moth *Carpocapsa pomonella* Linne, hibernating under treated paperbands placed around the trunks of the trees and the proportion wintering in other situations. Studies were made in orchards in southern Illinois during two winters on two ages of trees. The following table summarizes the data collected in these studies.

CODLING MOTH HIBERNATION IN BANDED APPLE TREES.

TABLE 1

A Comparison of Larvae in Band, on Tree, and on Ground.

	Per cent of Larvae Found in		
	Band	Tree	Ground
5 Trees 15-18 years. Winter 1932-33	90%	3%	7%
9 Trees 25-28 years. Winter 1932-33	77.8%	10%	12.2%
14 Trees Both ages. Winter 1932-33	81.4%	8%	10.4%
3 Trees 25-26 years. Winter 1931-32	78.8%	17.2%	3.5%
12 Trees 25-28 years. Both winters	78.6%	14.8%	6.5%

TABLE 2

Distribution of Larvae over Tree

(Not including those in Band or Ground)

	1931-32	1932-33	Both Years
Base Line	9%	5%	8%
Base to Main Crotches	11%	9%	10%
Main Crotches	3%	9%	5%
Branches	76%	75%	76%

TABLE 3

Height above ground of the larvae in the branches

	1931-32	1932-33	Both Years
4-10 ft. above ground	65.3%	73.7%	71.5%
10 ft. and up	34.7%	26.2%	28.3%

* Contribution from Project 9.1 of the Ill. State Nat. His. Survey.

TABLE 4

Location of Larvae according to Types of Cover

(Not including those in Band)

(1) On Tree

	1932-33
Rough bark	38%
Punky wood (knot holes, etc.)	29%
Split branches	25%
Crotches	4%
Pruned branch ends	2%

(1) On Ground

	1931-33
Decayed twigs, old prunings	11%
Aphis injured roots	30%
Apples or apple mummies	24%
Sprouts	15%
Old pieces of bark	3%
Dead weeds	9%
Trash, artificial cover	11%

TABLE 5

Location of Larvae in present season's prunings

Three trees, 25 years old, averaged 10 larvae per tree in the prunings just cut off, which was 37% of all on tree except band.

CONCLUSIONS

(1) Treated bands are well worth while, catching over ¾ of the larvae wintering on the tree and the ground under it.

(2) Of those larvae not in the band a larger part are usually found on the tree than on the ground.

(3) Of those on the tree ¾ are found in the branches, and in trees of this size, 20-25 feet high, ⅔ of them will be wintering within 10 feet of the ground.

(4) Of those on the tree more than a third are under pieces of rough bark, but many of the rest of them are in places rather inaccessible to birds and to any spray material which may be developed.

(5) It is evidently advisable to burn prunings since they contain an appreciable percentage of the larvae on the tree.